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THE FOUNDRY TRADE JOURNAL IS THE OFFICIAL ORGAN OF THE INSTITUTE OF BRITISH FOUNDRYMEN; THE WELSH ENGINEERS' AND FOUNDERS' ASSOCIATION, AND THE FOUNDRY TRADES EQUIPMENT AND SUPPLIES ASSOCIATION.

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Foundry Technical Institute, Meek's Road, Falkirk *(Telephone 332).*

Forthcoming Events.

NOVEMBER 7.

Society of Chemical Industry (Bristol Section):—Ordinary meeting at the Bristol University. "Recent Developments in Corrosion- and Heat-Resisting Steels," Paper by Messrs. T. G. Elliot, F.I.C., and R. J. Sarjant, M.Sc.

Institute of British Foundrymen.

NOVEMBER 2.

West Riding of Yorkshire Branch:—Ordinary meeting at Leeds. "The Solidification and Cooling of Metals," Paper by Professor A. Campion.

Lancashire Branch:—Ordinary meeting at Manchester. "Some Aspects of Modern Foundry Practice," Paper by F. Griffiths.

NOVEMBER 7.

London Branch:—Ordinary meeting in London. "The Founding of some High-Melting-Point Alloys," Paper by J. McNeil, A.R.T.C.

NOVEMBER 8.

Birmingham, Coventry and West Midlands Branch:—Visit to Foundry of Morris Motors, Limited, Coventry. Lecture on "Magnesium Alloy Castings," by E. Player.

NOVEMBER 9.

Wales and Monmouth Branch:—Ordinary meeting at Cardiff. "Making Iron in Primitive Times," Paper by Prof. Read.

NOVEMBER 14.

Institution of Welding Engineers:—Ordinary meeting at Caxton Hall. "The Manufacture and Standardisation of Eye-Protective Glasses," Paper by Dr. W. M. Hampton, B.Sc.

A Physical Conception of the Effect of Coal-Dust in Sand.

We very much appreciate Mr. S. G. Smith's logical elaboration of the theme set out in our recent leader entitled "Coal-Dust and Chaos." A very interesting and practical discussion followed its presentation to the Lancashire Branch of the Institute of British Foundrymen, but we are sorry that the lesson we endeavoured to teach was not learnt. For instance, the account of the meeting, as received by us, contained a large number of references to the "lighting of the air" instead of "igniting the mould gases." We must admit immediately that amongst a large section of the trade, mould gas is termed "air." But surely one has a duty to emend a technical expression if its use tends towards the chaotic. Whilst the nomenclature used at the meeting was of an indefinite character, yet it was clarity itself compared with an analysis of the pooled experience of the members.

The few factors about which there seemed to be general agreement were that coal-dust should be used sparingly; that it should be good, and that cognisance should be taken of the average section of the casting to be made.

It is an extraordinary fact that the effect of coal-dust upon the heat conductivity of sand was never touched upon, yet if one reads the report bearing this in mind, there is a wealth of evidence to support our conclusion that coal-dust operates favourably when making thick sectioned castings by improving the general heat-conducting properties of the mass and so bestowing upon the actual face of the mould easier conditions by allowing it to pass some of the heat received to the back. In this connection we would cite (1) the general case that where instantaneous freezing takes place, as in Mr. Primrose's light castings, no coal-dust is necessary—*because the sand has virtually no work to perform as a refractory*; (2) in the case of the 6 in. dia., 6 ft. deep cylindrical casting cited by Mr. Smith, there is the problem of pressure plus heat plus elapsed time—a problem wherein the refractory quality of the mould is serious, *hence the addition of a relatively good conductor of heat to the sand tends to cool the "business" face*, and (3) Mr. Longden's remark as to the substitution of mineral blacking for coal-dust indicates that it is a conductor of heat that is required in such cases. Finally, we feel so sure of our suggestion that we are prepared to advocate the inclusion of a still better heat-conductor—fine steel or iron filings for the improvement of the general conductivity of sand and so diminish the heat-resisting work put upon the skin of the face of the mould, which would be kept free from the metallic addition.

An Unsatisfactory Arrangement.

The work of the British Engineering Standards Association is widely known and appreciated in the foundry trade. This appreciation is based partly on general grounds but more significantly on the work that has been done recently in the matter of specifications for cast iron. It is therefore a matter of interest and importance to the trade that the Association has been officialiy incorporated this year—because this incorporation has involved (or rendered possible, as the case may be) a somewhat drastic reorganisation of committees. That the Association had outgrown its original somewhat loose construction we are prepared to grant, as also the fact that the new arrangement is on general principles a good one, perhaps even the best that could be devised. But we are concerned to notice the definitely unsatisfactory position that is occupied by the foundry industry as such and by ferrous products as such. The new constitution involves a council and thirteen industry sections, each of which has a committee and a varying number of technical committees with sub-committees. These committees are, of course, the ones already in active existence, but re-grouped under the new sections. It is, however, a little difficult to see on exactly what basis this new grouping has been made. Not on a basis of extent of activities, for the Automobile Section has one technical committee and the Electrical Section thirty-one! Not on a basis of process, since there is a Petroleum Section and a Chemical Section. Not on a basis of material, since there is a Public Works Section. All this, however, we are prepared to accept on the ground that the Association knows its own business best. What we are not prepared to accept in quite so unqualified a fashion is the fact that while there is a Non-Ferrous Section (presumably covering cast and wrought products), neither ferrous products nor founding appear among these main headings at all. This whole group of interests appears to be part of the province of the Mechanical Industry Section. Yet, with the exception of the National Federation of Iron and Steel Manufacturers, there is

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no direct representation of our interests on the committee of this section. Its importance is only recognised by means of representation on sub-committees both in this section and others, notably the four sub-committees of the Technical Committee on Cast Iron.

An arrangement of this kind postulates something of a misconception of the significance of cast iron to the engineer, and unfortunately it also postulates a continuance of this misconception, since the new arrangement is doubtless intended to be more or less permanent. This misconception is twofold. It is based first of all on a failure to realise that cast iron represents something like half or more of the bulk of the engineering products of the country, which fact alone should make it more than a matter of merely subsidiary interest. It is based, further, on the old idea that cast iron is a cheap material of poor quality, to be made the best of rather than improved. That this is not the case should be evident not only to those in the industry but to all who have come into contact with it through the work on the recent B.E.S.A. specifications. We may be mistaken in our impression, and the event may prove that the new arrangement will materially further our interests. But until we have such proof we are inclined to find in the new organisation of the B.E.S.A. one more reminder that engineers as a whole are too cavalier in their attitude to cast iron and the foundry generally.

Company News.

Neepsend Steel & Tool Corporation, Limited.—A bonus scheme in which the employees will benefit was described by Mr. C. S. Goodwin, chairman of the Neepsend Steel & Tool Corporation, Limited, at the annual meeting of that company held in Sheffield recently. Mr. Goodwin said that the scheme, broadly, was to capitalise the year's earnings and distribute a bonus on a basis of 4 per cent.

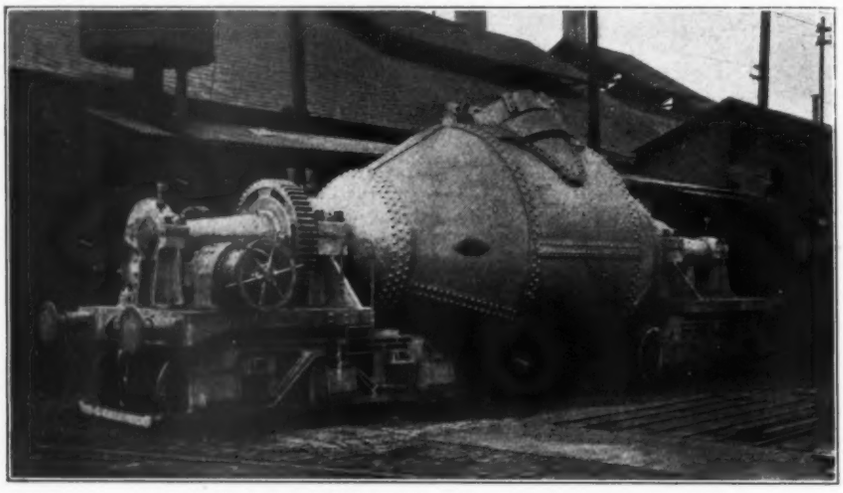
British Metallising Company, Limited.—The first ordinary general meeting of the British Metallising Company, Limited, was held recently in London. Mr. F. Heron Rogers (the chairman) said that the process which the company acquired and which had been amplified, lent itself not only to the production of silverware, but was capable of definite application to numerous industrial uses. Well over 100 proposals had been put before the company for metallisation. Negotiations were in progress for the sale of the American and Canadian rights. The works at home had proved too small, and they had lately acquired a factory at North Acton, which would fulfil all their requirements. The directors had received a proposal from the Metals Coating Company, Limited, for an exchange of shares.

A Large Hot-Metal Mixer Car.

AN ENGINEERING ACHIEVEMENT.

The engineering department of the Pearson & Knowles Coal & Iron Company, Limited, of Warrington, have built for the International Construction Company, Limited, of London, a large ladle for the handling of molten metal. This ladle, which is illustrated, is mounted on bogies, and is known as a "hot-metal mixer car," is intended for the transport of molten metal, and has a capacity of 125 tons. While such mixer cars are to be found in some of the large steel plants in the United States, this is the first of its type to be constructed in this country.

It is anticipated that in the near future such mixer cars will be adopted by British steelworks. The object of the ladle is to mix charges of molten metal from the blast furnaces, and to transfer them direct to the steel furnaces.



View of the 125-ton Hot-Metal Mixer Car.

The container itself, which has a rotary movement, electrically-driven, for filling and tipping, has a diameter of 10 ft. 6 in. and a length of 20 ft. It is brick-lined and is supported on cast-steel trunnions, the bearings for which are mounted on six-wheeled bogies. When the ladle has received its charge it is drawn by a locomotive to the steelworks, where it is tilted by means of the electric motor, which drives through a suitable reduction gearing on to a spur wheel mounted on one of the trunnions.

The overall length of the complete vehicle is about 40 ft. and its total weight is in the neighbourhood of 75 tons. Owing to the diameter of the ladle being greater than the space available at the platforms of railway stations, special arrangements had to be made with the railway company for its transport from the works of the Pearson & Knowles Coal & Iron Company, Limited, and it was necessary to partly dismantle it in order to accommodate it on special low-loading trucks.

Lancashire Merger Proposals.

The directors of the Pearson & Knowles Coal & Iron Company, Limited, state that they have given serious consideration to the question of the modernisation of industries associated with the production of iron and steel. In this connection negotiations have been entered into with neighbouring concerns with a view to an amalgamation of interests. The directors add that they hope to develop a scheme which, in due course, will be presented to debenture holders, shareholders and others interested. A similar reference to a possible amalgamation appears in the annual report of the Partington Steel & Iron Company, Limited, control of which is held by the Pearson & Knowles Company.

Random Shots.

Occasionally I occupy an idle minute by scanning the pages of a certain illustrated daily, left about by the females of my household. I was amused the other day to see in this very unexpected source the name of Bessemer. Someone had apparently unearthed in Camberwell Green—I quote from memory, and I don't know that part of London very well—an old forge that was used by Sir Henry Bessemer when conducting his original experiments with the process that subsequently bore his name. Perhaps there was a shortage of news that day—or more likely a shortage of society weddings, for I found a couple of paragraphs on the subject on the gossip page and a photograph elsewhere! Not that there was anything very striking about the photograph. It might equally well have been a garden entered by burglars, a house inhabited by an elderly eccentric, or something of that sort.

* * *

In the case in question I have no reason to doubt that the photograph was other than it claimed to be. But one cannot always be so trusting. There was, for instance, a striking photograph of "His Majesty the King out Shooting for the First Time since his Illness"—in the same quarter, as it happened. And when the loyal subject read the caption, this is what he found: "His Majesty . . . was out yesterday . . . with a special light gun. . . . This picture was taken on a previous occasion"!

* * *

My remarks on longevity have called forth a most interesting correspondence, from which I have culled a few extracts for your particular benefit:—

"Nonagenarian" (Middlesbrough) writes: "There's nothing to beat core-oil, well rubbed in. Man and boy I've worked in the foundry, and I've never known anyone who did this to die young!"

"Great Grandfather" (South Wales) writes: "I find that the presence in the air of minute particles of moulding sand has a strong disinfectant effect. It appears to be absolutely fatal to all kinds of germs. Since I discovered this I have practised deep breathing when at work, with the most beneficial results."

"Rip Van Winkle" (Mannheim) writes: "Although now in Germany am I acclimatised, in England was I born, and your most interesting paper with pleasure do I invariably read. I have for one hundred and two years without a stop lived, and I have my success in this respect to the large quantities of German beer which I always daily imbibe for a long time attributed. Allow me this method to your kind readers respectfully to recommend."

* * *

I haven't been to the Motor Show myself this year, but I'm told that in a world agreed to be at sixes and sevens this particular event is all at sixes and eights.

* * *

Do you know this Scottish story? The family was gathered about the bedside of the dying father. Said the old man: "Is John here?"

"Ay, I'm here, father." "And is Sandy here?" "Ay, Sandy's here, father." "And where's Jean?" "She's here too, father." "Oh," said the old man, "if you're all here, who the de'il is looking after the shop?"

* * *

Quotation for the Week.

"Too many young couples marry in Hastings and repent at St. Leonards." (Attributed to Mr. Seymour Hicks.)

Marksman.

The Metals Coating Process and Foundry Practice.

Foundrymen have long been familiar with metal coating by means of the metal-spraying pistol, but the recent exhibitions in Düsseldorf and at Olympia showed in the clearest possible manner that the process had developed from the experimental to the commercial stage. Briefly, the process consists in automatically feeding into the pistol any metal or alloy obtainable in the form of wire, where contact is made with an oxy-acetylene flame which melts the metal wire, and in association with compressed air blows the atomised metal against a surface to be coated at a velocity of about 3,000 ft. per sec. Naturally, such a coating, if properly applied, becomes part and parcel of the job in hand, and bending or hammering fails to effect a separation.

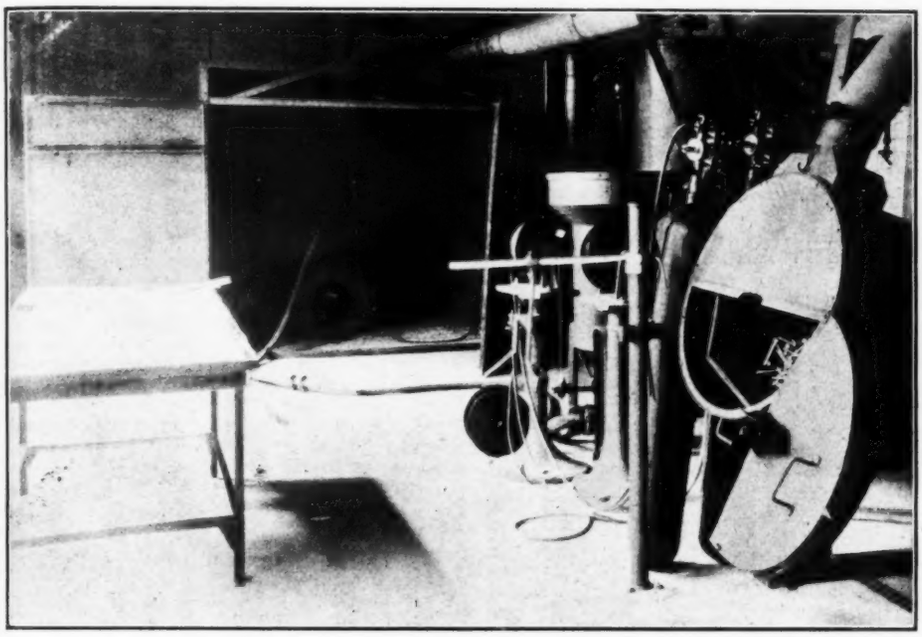


Fig. 1.—A Typical Metal-Spraying Lay-out.

The Metalayer, as the pistol is called, contains a feed mechanism which feeds the wire through the nozzle at a rate of from 12 to 24 ft. per min., depending upon the character of wire used. At a position about $\frac{3}{32}$ in. from the muzzle of the pistol, the wire enters a reducing zone, so that excessive oxidation is prevented. It is stated that the compressed-air consumption is (at 50 lbs. per sq. in.) in the neighbourhood of 50 cub. ft. per hr., whilst the oxygen and acetylene are each consumed at the rate of 15 cub. ft. per hr.

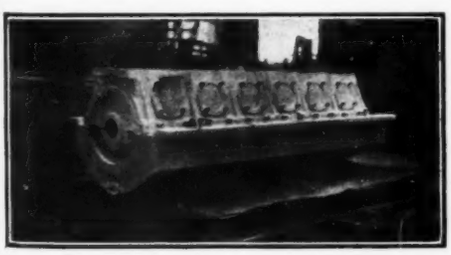


Fig. 2.—Large Crank Case Sprayed with Zinc.

Operating Details.

The Metalayer only weighs $3\frac{1}{2}$ lbs., and normally is operated by hand, but obviously, for certain purposes, it is mechanically held and the object to be coated moved or *vice versa*. Founders are better placed than most industries for its practical application, as the makers insist that sand blasting is a prerequisite for obtaining a clean open-grained surface. There is a still closer analogy when dealing with small parts for an apparatus is used, which resembles very closely a sand-blast barrel, carrying, instead of a sand-blast nozzle, the metal-spraying pistol.

Foundry Applications.

The moment the Metalayer has firmly established itself in British foundries (there are, of course, a fair number of users already) as it has in Germany, then its possible applications becomes an exceedingly interesting speculation. Primarily, there is the question of patterns. In the case of wooden ones, the life might be prolonged very considerably by spraying with a cheap non-corrodible alloy so as to give a smooth surface. Again, for the shipyards, where patterns are so often stored in the open air, a weather-proof coating could be applied. Metal patterns after making from 20,000 to 40,000 castings become worn, and this suggests another application, that of restoring them to their original size.

An application, which, if we had been commercially inclined, we ought to have patented, is the spraying of moulds, with the object of attaining differential cooling, that is the replacement of chills and denseners. Even if this application be ruled out on the grounds of insufficient thickness of chill, there is still the possibility of its application as a reinforcement of a mould to prevent the sand washing away.

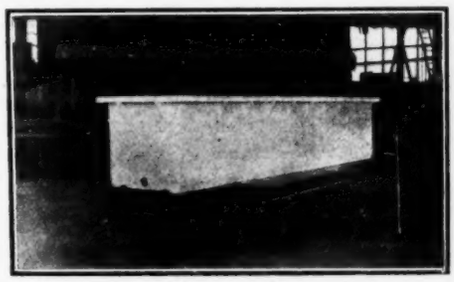


Fig. 3.—C.I. Annealing Box Sprayed with Al.

Runners, too, could be kept cleaner. In this suggestion it is not necessarily advocated that sides of moulds be sprayed, only the bottom-face. Gas generated behind the metallic film would be carried away by the normal means—venting, cinder beds and the like. Gases generated in the metal would obviously rise. Surely mould gases should not be expected to rise through a body of liquid metal.

If this effort produced blow-holes, we can think of no better method of disguising than by filling them with an alloy of the same colour and composition if possible. Moreover, if a pattern produced a castings minus its machining allowance—and such things have been known—then once more recourse could be made to the piston. (*Continued on Col. 3, page 314.*)

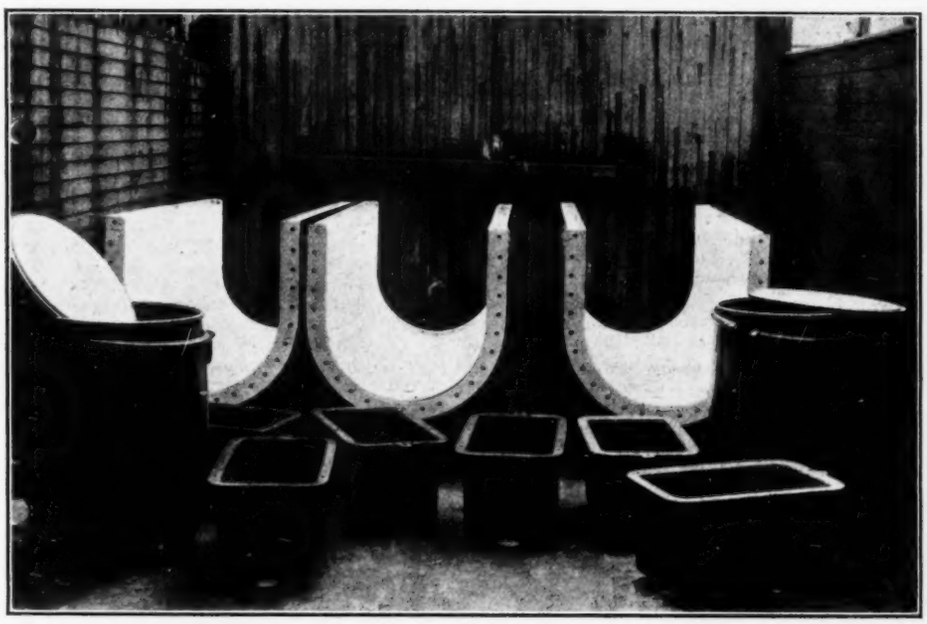


Fig. 4.—A Day's Output from one Metal-Spraying Pistol.

Thoughts on Modern Melting Methods.

MR. RIDSDALE'S PRESIDENTIAL ADDRESS TO THE MIDDLESBROUGH BRANCH OF THE I.B.F.

The inaugural meeting of the current session of the Middlesbrough Branch of the Institute of British Foundrymen, held on Friday, October 11, was noteworthy for an encouraging address given by the President, Mr. N. D. Ridsdale, who during the evening appealed to the members to support Dr. Ingall, principal of the recently-opened Constantine Technical College, at Middlesbrough, in his scheme for foundry education of apprentices.

Great enthusiasm was shown among the members regarding the preliminary announcements concerning the Institute Convention, which is to be held at Middlesbrough in June or July of next year.

At the outset of his address the President took the opportunity of welcoming all members and visitors, and stressed the welcome to Dr. Ingall, who had just been received into membership.

The President recently accompanied a party of foundrymen organised by the British Cast Iron Research Association on a visit to the Foundry Exhibition at Düsseldorf and to several German foundries. His presidential address took the form of a commentary on the modern methods of remelting and refining cast iron on the Continent as compared with the English practices.

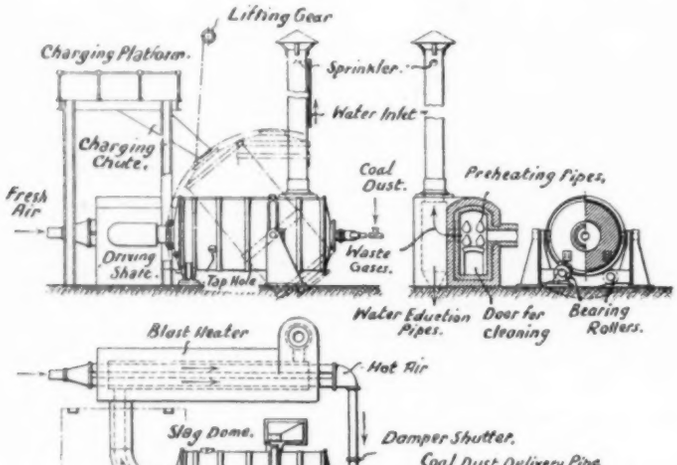


Fig. 1.—The Brackelsberg Rotary Furnace.

Mr. Ridsdale said the first works visit was to the works of Senff & Sohn, Suchteln, near Düsseldorf, to see the Brackelsberg rotary furnace for remelting and refining cast iron. This is a new design of furnace fired by means of pulverised fuel. Articles referring to it originally appeared in the German foundry journal "Die Giesserei," and translations of these recently appeared in The Foundry Trade Journal (April 4, September 12 and 19, 1929).

The furnace was originally intended for producing high-quality malleable iron, but can be equally well employed for remelting and refining any high-duty iron. The furnace had a capacity of 5 tons, but furnaces are made in sizes from 1½ to 10 tons.

Fig. 1 gives a general view of the furnace. It consists of a horizontal cylindrical shell about 13 ft. long and an inside diameter of 3 ft. It is carried on rollers at its base, and can be rotated at a slow speed during operation. It can be tilted to an angle of 30 deg. from the horizontal for the purpose of charging it. The shell of steel plates is lined with a plastic highly-silicious refractory. The fuel used was German brown coal, containing ash 12 to 14 per cent., volatile matter 20 to 30 per cent., sulphur 1 to 1.5 per cent., and a calorific value of about 13,000 to 14,000 B.Th.U. The coal is ground to pass 170 mesh. The powdered coal is blown by means of air at a pressure of 10- to 13-in. water gauge by means of a fan. The air can be readily controlled so as to yield a flame which is either slightly oxidising or weakly reducing. Melting is carried out much faster than it is in the fixed reverberatory furnace, and, except during melting, the metal does not come into contact with the flame to any great extent. Owing to this, and a thin covering of slag, it is possible to melt without any significant oxidation or increase of sulphur. According to Dr. Kelper's tests, when melting malleable and grey iron, metal losses were as follow:—Carbon, 0.11 to 0.18; silicon, 0.25 to 0.40 (on 4 per cent. Si); manganese, 0.02 to 0.07; and sulphur, 0.001 to 0.004 per cent. gain. The total ascertained loss was only 0.62 to 1.22 per cent., and the iron in the slag only 0.15 per cent.

A 4-ton charge of grey iron took 2¾ hrs. to melt, and was poured at 1,400 deg. C.; subsequent charges, it was said, would only take 2¼ hrs. to melt.

The coal consumption was 14 per cent. of the metal when melting malleable iron, but with grey iron it was only 12 per cent. The fuel ratio does not appear to be much higher than in the cupola, whilst in Germany, at any rate, the cost of pulverised coal is appreciably below that of foundry coke. The cost of pulverising coal in the Berg mills is stated to be only 2s. 6d. per ton.

The furnace would appear to be capable of yielding hot iron, and the total carbon and other elements can be readily controlled so as to yield a high-quality fluid iron more free than usual from oxides and dissolved gases suitable for special castings.

Fig. 2 shows a general view of the furnace, including the auxiliary pulverising plant and air fan. Any likelihood of this furnace supplanting the cupola only applies to cases in which high-duty iron is being melted. It will probably be a long time before continuous supplies of ordinary grey iron (phosphoric) can be melted more simply and economically than in a modern cupola.

The Buess Furnace.

Several furnaces of this type are now working in Germany, but another pulverised-coal-fired rotary furnace for which even greater claims are made is known as the Büess furnace.

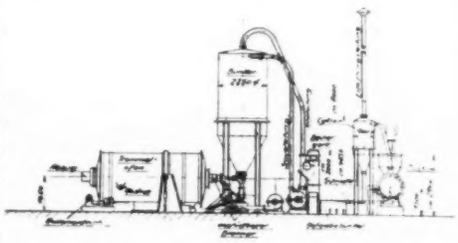


Fig. 2.—General View of the Brackelsberg Furnace.

A general view of this is shown in Fig. 3. The chief difference between this and the Brackelsberg furnace is that the horizontal chamber is mounted eccentrically at each end, and when it revolves this gives a swirling motion to the charge, which gives quicker reaction with the slag and ensures thorough mixing when melting steel or adding ferro-alloys. This swirling motion was ingeniously illustrated in the foundry exhibition by means of a glass cylinder, mounted eccentrically, somewhat similar in shape to the Büess furnace and partly filled with water containing dried peas floating in it and stained different colours. Another glass cylinder was rotated concentrically to illustrate the motion of the Brackelsberg furnace, and, whereas the peas were in continuous motion in the eccentric cylinder, they were practically motionless in the concentric one. I was told that a well-known firm of malleable castings manufacturers in the Midlands sent representatives to investigate the two types of furnace in Germany, and decided to build a Büess furnace and to purchase the exclusive patent rights for Great Britain. Fig. 4 shows a cross-section of the Büess furnace.

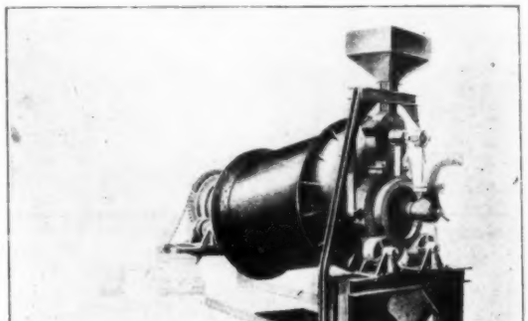


Fig. 3.—The Büess Furnace.

Another works visited was the Vereinigte Stahlwerke at Gelsenkirchen. This works was peculiar in having its own blast furnaces with foundries attached, but no steelworks. The furnaces were of the modern American mechanical charging type, and these supplied molten iron to two 150-ton gas-fired mixers of a similar pattern to those used in modern steelworks. The mixers were fired by means of producer gas and surplus blast-furnace gas. In one mixer grey iron con-

taining about 2.5 per cent. silicon and 0.8 per cent. phosphorus was stored. This iron supplied the light castings foundry with molten iron as required. The other mixer supplied iron with about 2 per cent. silicon for making heavy iron pipes by the centrifugal process, somewhat similar to that practised by the Stanton Iron Company. It is unusual to find a works supplying iron to the foundries without remelting it, but

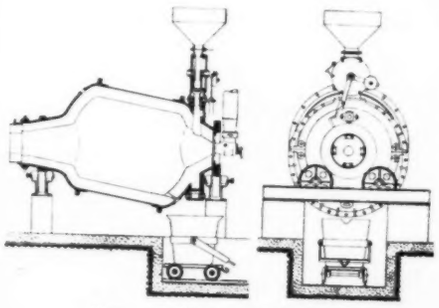


Fig. 4.—Cross-section of the Büess Furnace.

there is no doubt that such a method is much to be commended for heavy work, since at least 10s. a ton is saved through avoiding remelting and the iron is hotter and under better control than metal usually delivered from cupolas. One of the most up-to-date works visited were those of the Motorenfabrick Deutz at Cologne. This company makes motor cylinders, gas and Diesel engines, etc. Some of its high-duty cylinder iron is melted in the cupola and then transferred to an electric furnace, where further steel additions may be made and the refining completed. This enables them to carefully control the quality of the iron and to cast at high temperatures. Most of their cupolas were fitted with D-shaped receivers which could be tilted by electric power. The receivers had teapot spouts to keep the slag back. These cupolas were producing another quality of cylinder iron containing about 3.1 per cent. total carbon and 1.2 per cent. silicon. The cupolas were fitted with a water spray just above the charge door, with the principal object of keeping the top cool for the comfort of the men. Each cupola was fitted with a meter to measure the pressure and the volume of the blast.

In the foundries which were working full time the men work 9 hours a day from Monday to Friday and 7 hours a day on Saturday. We were told that the average wage was about 52s. for a 52-hour week.

The exhibition was particularly well organised, and the exhibitions were very well displayed. There were a number of working models of different kinds and demonstrations of moulding machines, sand-handling machines, etc.

In dealing with modern methods of melting cast iron, reference should be made to the Poumay system of cupola control. I am informed that there are about 400 cupolas built or converted to the Poumay system on the Continent and nearly 50 in this country. The devotees of this system in Great Britain show a saving of fusion or charge coke since cupolas were altered to the Poumay system of from 22 to 55 per cent., and in one case a saving of 72 per cent. In many of these instances, no doubt, a considerable saving in coke could have been effected by modernising their ordinary cupola practice. The average fusion coke used in the Poumay system is reduced to about 6 or 7 per cent. of the weight of iron charged. It is true that for ordinary phosphoric grey iron with modern melting conditions in the cupola fairly low coke consumption can be obtained, but not as low as in the Poumay.

There are certain important differences between the Poumay system and ordinary good modern cupola practice; and it is only fair to give Mr. Poumay credit for it. In good modern cupola practice sufficient air is introduced at the tuyeres to theoretically burn the carbon to carbon dioxide at the zone of fusion, which takes the form of an inverted cone whose base is, perhaps, 2 ft. above the tuyeres. If enough air is blown in to permit an excess of oxygen—beyond that required to form carbon dioxide—to be present at the fusion zone, the cooling effect of it will cause the iron to be dull and oxidation will be excessive. The analysis of the gases at the throat of the cupola might show that nearly all the CO was burnt to CO_2, but in spite of this the resultant iron would be far from satisfactory.

On the other hand, if only enough air is introduced to form CO at the fusion zone in an ordinary cupola no carbon dioxide will be formed at any stage beyond this, and the fuel consumption will be high, whilst the quantity of iron melted will be small. In the best ordinary cupola practice, when there is enough air introduced to theoretically form carbon dioxide at the fusion zone, some of the carbon dioxide reacts on more coke higher up in the descending

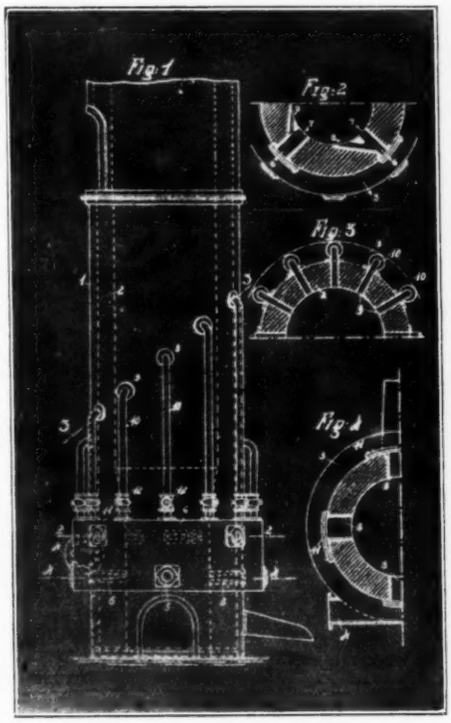


Fig. 5.—The Poumay Cupola.

charge and is converted to carbon monoxide, so that there is always unavoidably from 5 to 10 per cent. CO in the throat gases, with corresponding loss of efficiency.

As a matter of fact, carbon dioxide dissociates at temperatures much above 1,000 deg. C. into carbon monoxide and oxygen, so that carbon dioxide heated to the temperature of molten iron will to some extent oxidise it, though no doubt most of the oxidation takes place whilst the molten iron trickles down between the fusion zone and the tuyeres level. I am indebted to Mr. John Cameron, J.P., of Kirkintilloch, for some slides of the Poumay cupola, and some information from Mr. Poumay, who makes it clear what are his special claims.

Mr. Poumay makes a point of just introducing sufficient air at the main tuyeres to convert the carbon of the coke to CO (not CO_2) at the fusion zone. In this way oxidation of the iron on melting and dripping through the coke bed into the well is reduced to a minimum. Between a point just above the fusion zone and within 3 or 4 ft. of the charging door at the top, a series of small blast pipes or regeneratory tuyeres are led from the wind belt into the side of the cupola in the form of a spiral. The object of having a number of small auxiliary tuyeres, each one on a different level, is *gradually* to burn the CO above the fusion zone to CO_2 and to impart the heat given out to the descending charge without localising it.

Fig. 5 shows a diagram of the Poumay cupola with bottom tuyeres, at (4) smaller divided tuyeres with tangential branches at (2), and auxiliary tuyeres up the side, and Figs. 6 and 7 the Greiner cupola for comparison.

In order to get a more regular product from the cupola, more attention should be given to the condition of the material charged into it. The Paper given to us last session by Prof. Briscoe at Sunderland at the joint meeting* of the Newcastle branch with our own, referred to the importance of the size of the coke as well as to its quality. His experiments seemed to show that pieces between 1½-in. and 3-in. cube gave the best results, even on a large 5-ft. cupola. It should be possible to buy hard sorted coke of about this size at a price rather lower than ordinary foundry coke, and the founder in this district who is enterprising enough to make experiments using graded coke has every prospect of effecting an economy and getting better results. It must be remembered, of course, that a smaller coke will require a some-

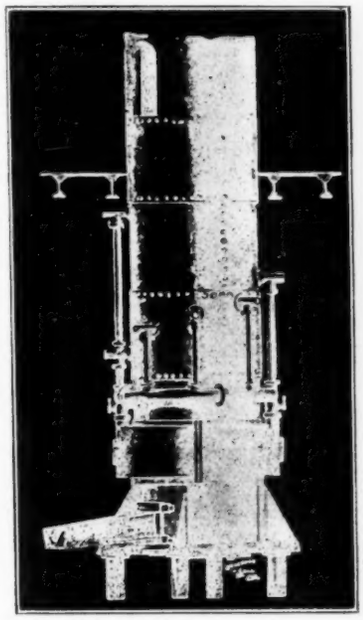


Fig. 6.—The Greiner Cupola.

what higher blast pressure owing to the reduced space between the pieces. Smaller coke will give a higher maximum temperature of combustion and a shorter combustion zone, and should reduce oxidation. With regard to the iron charged, regular results can hardly be expected if massive pieces of metal and scrap are introduced into the cupola unbroken.

In Middlesbrough district, including Stockton and Hartlepool, but excluding Darlington, there are about 28 iron and steel foundries, apart from several brass foundries, and the number of employees in these foundries is probably at least 2,000; if on an average only five employees of a foundry were members of our local branch of the I.B.F., we should have 140 members. Is this too much to expect from a large iron-making district like this? Out of the 28 foundries in our district, only 18 have any employees who have joined our branch, whilst 10 more foundries have not a single representative amongst us. It is true that our branch has only been established about three years, and we can be grateful for what has been accomplished in that time, but it is well to recognise that there is

* See F.T.J., April 25, 1929, page 307.

room for a very considerable growth in membership, and that if the forthcoming Convention next year is to be a success and to do credit to our district, our branch should be very much better supported by the local foundries, so it is hoped that every member will make a special endeavour this session to gain new adherents.

Two years ago he succeeded in stimulating some interest in foundry education, and classes were started in Middlesbrough, and later in Stockton, for foundry apprentices. The attendance at first was very good, but it rapidly diminished to a mere handful of earnest workers, so that this autumn I understand that up to the present no arrangements have been made to start a class. However, I believe facilities for foundry education are being undertaken at the new Constantine Technical College, and it is hoped that local foundries will interest their employees in it. On the Continent considerable strides have been made in educating the foundryman both on the technical and practical side, and there is not the slightest doubt that, unless a much greater effort in this direction is made in Great Britain within the next few years, our Continental friends will leave us behind.

A recent letter from Mr. John H. Smeeton to the technical Press throws light on German efficiency in this respect. He says:—"During the recent International Foundry Trades' Exhibition in London I met Dr. Engineer Professor Paschke, of the Clausthal Technical Academy, which is situated in the Hartz mountains, and received from him a cordial invitation to visit his University. I have recently returned from a visit of six days to Clausthal, and desire to place on record the very generous and courteous reception I received and my amazement and admiration at the perfection of the training given to the students in every branch of the metal, coal and chemical industries.

"Each student is first given a general training, and, having decided into what particular branch of the industry he desires to enter professionally, he is then specially trained in every minute detail of the industry, both technically and practically, so that he leaves the college fully equipped to fill an important position as under-manager or even manager of works.

"*Every professor employed at the college has previously occupied practically the highest positions in the industry before accepting his professorship*, and all hold University degrees. They still continue to act in a consulting capacity to the companies with whom they had been previously associated, and the rules of the college allow a considerable licence in this direction, to the advantage of the industrial organisations, which get the benefit of the research work which is being constantly carried on.

"I came away with the feeling that the German colleges are extremely serious in their intention to turn out students who are perfectly educated in every detail of their particular profession, and that we in England will have to adopt many of their excellent and thorough methods if we are to continue to compete with them in the markets of the world."

At the German Foundry Exhibition, and in a small room leading from the main machinery hall and a smaller one devoted to rationalisation, the panels were decorated with seven pictures representing the seven cardinal sins encountered in foundry practice, which have been reproduced in The Foundry Trade Journal.

In conclusion, I wish again to thank you for electing me as president for the ensuing year, though I regret that the position was not filled by someone having longer associations with foundries and more intimately connected with them on the practical side. However, I look forward to your co-operation with me in making this a record session in growth, attendance and general usefulness.

Vote of Thanks.

Mr. F. P. Wilson, J.P., Past-President of the Branch, supported the President's appeal to members in regard to the forthcoming Convention. "This is going to be a very important event for us, and the Committee is anxious to secure your interest in the matter," he said.

Congratulating the President on his admirable, interesting and informative address, Mr. Wilson said that Mr. Ridsdale's visit to Germany had, through the medium of his illustrative address, been as interesting to the members of the Branch as it must have been to the President himself.

In proposing a vote of thanks to the President, Mr. S. B. Thorpe expressed the hope that all members present would unite in bringing new members to the Branch and making the coming season an even greater success than that of the past year.

Mr. J. Habgood seconded this motion, which was carried with applause.

Responding to the President's welcome to membership, Dr. Ingall said that the subject of foundry education was a very important one. "We have to live more by our brains. Brains are as much of value in foundry work as in any other branch of industry. There is no doubt about what is going on in other countries, and if we do not do something, we shall be left behind. I have taken particular interest in the foundry industry in all parts of this country, and especially in regard to the provisions for technical training.

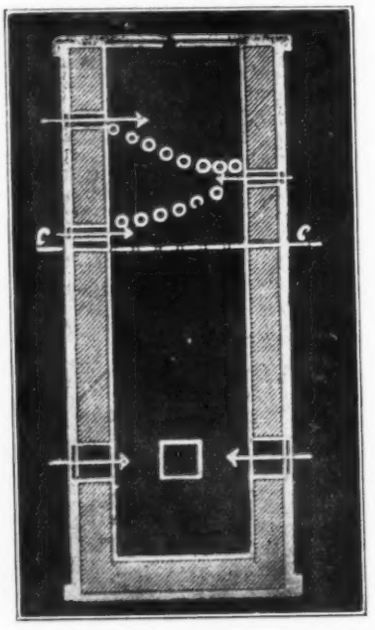


Fig. 7.—Section of the Greiner Cupola.

"The technical colleges have failed, and the employers have failed on their part. My own feeling is that the reason for the failure cannot be attached either to one side or the other. The solution lies in co-operation between the two."

Proceeding, Dr. Ingall said that he had prepared a scheme which he had tried to introduce in South Staffordshire. The scheme was turned down, but, after interviews with the leaders of the foundry industry on Tees-side, he had been able to set up an advisory committee to investigate the problems of foundry education.

The committee, he went on, consisted of representatives from the concerns participating in the scheme, and arrangements had been made to put the scheme into immediate operation.

Dr. Ingall proceeded with a description of his scheme. The intention was, he said, to have students from the foundries—three students from each firm participating in the scheme—who would be divided into two sections.

The two classes would carry on with that work for two years. At the end of that period the best members of the class would then attend the College for three nights a week to continue their training. This training will enlarge the visions of the students so that they will be ready and competent to develop any side of the industry in Middlesbrough and bring it up to par with any country of the world.

"The classes will be starting quite shortly, and in this way Middlesbrough will light a candle which will make the rest of the country sit up and rub their eyes."

In conclusion, Dr. Ingall said that he was asking the Branch to nominate a member to sit on the advisory committee which would put this scheme into operation. The Chairman (the President) said the Branch wished the scheme every success.

The Metals Coating Process and Foundry Practice.

(*Continued from page* 311.)

Finally, there is the question of the finished casting. Those destined for corrosion-resisting purposes could be zinced. The manufacturers, Messrs. Metals Coating Company, Limited, of 22, Birchin Lane, London, E.C.3, insist that the process is much cheaper and more effective than galvanising, whilst castings for domestic consumption could have their appearance improved by making them resemble bronze. Stencilling is still another possibility. This last phase we saw being adapted, in the Düsseldorf, to protect parts required to be unaffected from being case-hardened during the operation of that process.

Actual Results Achieved.

Fig. 1 shows the corner of a room devoted to metal spraying. In the background there is an ordinary blast room, whilst at the right is an apparatus resembling the ordinary sand-blast tumbling barrel. Herein the spray of metal is directed upon the constantly moving small parts.

In Fig. 2 we illustrate a marine engine crank-case casting which has been sprayed with zinc;

Fig. 5.

whilst Fig. 3 shows a cast-iron annealing box which has been coated with aluminium. Obviously the question arises as to speed of working and also the versatility of the process. In order to get a mental idea of this, we have reproduced a photograph of a day's work (Fig. 4). This shows a day's work accomplished by means of the Metalayer. It comprises three mixer pans coated with aluminium, four cast-iron pots coated with lead, two cast-iron pots coated with tin and two steel drums, one copper and one lead coated.

Fig. 5 presents features of interest, because the curb is wooden, but coated with bronze. The other objects illustrated are iron castings or forgings which have been finished with a bronze coating.

Coal-Dust and Chaos.

PROBLEM STILL DEFIES ELUCIDATION.

The first meeting of the Session was held at the School of Technology, Sackville Street, Manchester, on October 5. Mr. E. Longden presided.

In opening the proceedings, the PRESIDENT, who has been re-elected for a second year of office, remarked that it was not his intention to inflict a second presidential address upon them. During the last session they were well served with a series of lectures of a varied character, and the visits to works, arranged for the summer, were greatly appreciated by the members.

At the conclusion of the session they were honoured by a visit to the Manchester district of a large number of noted international foundrymen. Whilst they did their best to act as hosts in the highest sense, he feared their efforts were not comparable to the great welcome received by those who were fortunate enough to visit the U.S.A. in 1926.

He should like to impress upon the members the duty they owed to the Institute to secure suitable recruits for the I.B.F. Was it possible for them each to secure one new member during the next month or two?

It had been his intention to talk of the possible and probable development in the industry, but that could be deferred until some future occasion, because the subject had been ably dealt with recently by the Editor of THE FOUNDRY TRADE JOURNAL and by Mr. Lucas in his presidential address to the East Midlands Branch. He would, however, like to say a word or two on the subject. To those who had followed developments in the foundry trade it would appear that there had been only slow progress in the control of cast iron. Much theory had been propounded but little of real service had been given to the foundry trade. That was to be expected, owing to the very complex nature of cast iron. Other metals were better understood. He was one who believed that they could not secure as good cast iron to-day as in their fathers' days unless they paid an exceptional price for it.

If a reduction in costs was to be brought about, it would be necessary to develop more and more on the lines of continuous flow movements and the mechanising of our foundries. It was only by progressing along on such lines that they would get a better return for their labour and enterprise.

Coal-Dust and Chaos.

A discussion on "Coal-Dust and Chaos" was opened by MR. S. G. SMITH. He said that when invited to open a discussion at the first meeting of the session upon some problem or phase of foundry work, a difficulty presented itself regarding a subject of interest, not that there is a dearth of such, as there are many foundry questions which still appear to be problematical. However, the subject chosen was settled after reading the editorial notes and the discussion on Mr. Ben Hird's Paper, "Coal-Dust as applied to Moulding Sands," read before the International Foundrymen's Congress this year.

The title is borrowed from the leader in THE FOUNDRY TRADE JOURNAL of August 22, 1929, "Coal-Dust and Chaos," which befits the discussion, as it reveals an amazing array of dissimilar opinions and, as the editor aptly puts it: "We cannot imagine that generations of foundrymen the world over would continue to incorporate coal-dust in the sand mixture for the pleasure of making the sand dirty."

He offered no criticism on Mr. Hird's Paper, as that gentleman had done the research work in an able and a very commendable manner, which reveals the love of the matter he has taken in hand.

If the discussion as it appeared was analysed, what did one find? He deemed it worthy of consideration and invited an expression of opinion from the members of the Branch. Apart from any expressions now made, some suggestions might be offered that could be carried out in one's own foundries in daily practice. He was sure that such experimental work would lead to definite results, and he requested that the subject be approached with an open mind, as there appeared to be quite a tangle of misunderstandings.

He excused himself for stating that he had probably practised as a journeyman moulder, foreman and manager with as many grades and varieties of moulding sands as any living foundryman. His experience extended considerably more than 50 years in active service, embracing practical and technical work. Hence, as a teacher to foundry classes and lecturer to students on foundry subjects, he was desirous of "getting down" to the truth of the principles that underlie practice and he hoped the discussion would clear the air.

Origin of Pock-Marking.

Mr. Hird set out to show the action and influence of coal-dust in the facing mixture during pouring. An examination of the discussion in the order as published deals first with the origin of pock-marking. From experiments in practice he found that real pock-marking might be attributed to the use of new, raw sand, the reason for this being that in all raw natural foundry-moulding sands there exists a bond. This bond-substance varied chemically, physically and in quantity in the various sands, quite regardless of colour or district where quarried, and the terms strong, medium and weak were adopted to indicate the clay or bond content. (See THE FOUNDRY TRADE JOURNAL, September, 1909, and January, 1912 and 1917.) It was due to the nature of the colloidal, jelly-like and sticky bonding matter, also the proportion of mixture, that pock-marks were due.

This could be illustrated by the following example:—If a thin plate, $\frac{1}{8}$ in. thick by 12 in. sq., were cast into a green-sand mould made with a very weak new sand, *i.e.*, containing very little bond or clayey matter, no coal-dust, the usual amount of moisture and suitably rammed, pock-marks might, or might not, appear, but if a new sand were used a little richer in bond, then the plate was sure to show pock-marks.

The following illustration shows that there is a relation between thickness of casting and freedom from pock-marks:—If a plate, 1 in. thick, were cast in the same weak sand, it would show no signs of pock-marks, but if the sand were sufficiently strong, an inch-thick plate would exhibit pock-marks.

The pock-marks were produced when the molten iron came into contact with grains or particles of sand coated with the clayey matter or sticky bond, then a slight expansion or a blob of gas occurred forming the pock-mark, which did not, owing to the thinness of the plate, recover its true or original shape. This was borne out in the remarks of some of the speakers. The proof and truth of the foregoing could be tested and carried out in daily routine work by any foundryman.

Pock-marking due to the addition of coal-dust was very rare; the appearance and indentations of such were quite different. It was a shiny or bright, comparatively large, very smooth speck with a clean blue skin, and it was due to the coarseness and proportion of the coal-dust present. Why an inch-thick plate was free from pocking and the thin plate exhibited them, was due to the greater and prolonged intense heat imparted by the metal. In the case of the thin plate solidification occurred in seconds, hence a minute flutter or expansion of gas or air from the material comprising the mould left its permanent impression on the casting. With the thick plate solidification occurred in minutes, allowing the metal to assume its true form after the gases had been dissipated. In the presence of moisture this phenomenon would occur whether the plate was cast open-sand or covered, but the pock-marking would be more pronounced in the open-sand plate, due to the absence of pressure.

Neither pock-marking, pitting, mapping, vein-marks nor part-fusion of the weak silicates could occur if the facing sand were correctly mixed, *i.e.*, correctly graded and prepared, which, of course, included the correct proportion of a suitable coal-dust for various sections of castings required.

There was a hidden truth underlying the statement of a participant in the discussion: "That the chemistry of the reaction between the bonding substance and the volatile gases under the action of heat was very much responsible for the peeling phenomenon observed in many sands."

Coal-Dust and Venting Properties.

The addition of the necessary amount of coal-dust, which was comparatively infinitesimal in a facing sand, neither increases nor decreases the venting properties of the sand. If this small addition, usually about 5 per cent., partly filled in the spaces between the regular size grains of sand, its permeability was unaffected, due to the burning of the coal-dust.

Carbon Absorption.

Carbon absorption, either by the sand or metal, need not concern them, as in practice its effect, if any, was not detrimental. Skin hardness of castings was quite another matter and was not due to a small percentage of coal-dust.

Tarry Constituent in Black Sand.

The statement made regarding this constituent in black sand, *i.e.*, floor sand, "that 50 per cent. of the black material was soluble in various reagents" was not surprising. When one considered the many times partly-burnt kinds and values of various bonds of high percentages under the repeated action of heat upon these, the statement appeared quite possible. It would astonish many who have not tried the simple experiment of partly separating the bond from the sand grains. The amount of the jelly-like substance shown from the various sands might be a revelation. It was the practice in many steel foundries to coat the moulds with raw tar. In some cases it was probable that the whole of this had not been disposed of or burnt when casting, hence a tarry residue remained in the sand.

Are Coal-Dust Additions Necessary?

Was the use of coal-dust advisable in green-sand mixtures? Also, was the addition of horse manure and other similar materials necessary? One thing was quite clear: the addition of coal-dust to any sand mixture, other than green sand, was unnecessary. This statement applied to both moulds and cores made in green sand; moulds made with a green-sand mixture and afterwards partly dried were included. Whether the use of coal-dust, manure, milling, etc., was necessary depended largely on the sand as delivered to the foundries.

He was familiar with most grades of Erith sands, also Worcester, Birmingham Bunter, Notts, Lancashire and Yorkshire sands, having worked as a moulder and experimented as an investigator with these sands when making various kinds of castings, varying in weight from ounces to tons. He felt justified in making a modest claim to express himself regarding a suitable facing sand, and why the addition of coal-dust, manure and such like was necessary to some sands.

It was quite possible in practice to make light-section castings continually in certain

sands without the use of coal-dust. Such a grade of sand was generally a mild weak sand, but it did not follow that with this sand all sorts and sections of castings might be made. It was possible to make a 1-in. section casting without the use of coal-dust if a good plumbago was rubbed on the surface of the mould, but it was not possible in the absence of a carbon blacking to make a clean thick-section casting, say, from 3 to 9 in. thick by 6 ft. deep, in green sand, without the addition of coal-dust.

To test the truth of this statement, the following or a similar experiment was suggested:—Make a cylindrical casting, 6 in. dia. by 6 ft. deep, poured vertically at a temperature of between 1,300 deg. and 1,400 deg. C. A firebrick or a piece of strong loam cake should form the bottom of the mould to take the drop of the metal, which may be poured through a strainer runner-basin from the top. The ramming should be consistent with the depth. The facing sand applied to the bottom 2 ft. of the casting may be a medium or average sand, regardless of colour, without the coal-dust addition. For the middle 2 ft. the same kind of sand should be used, with the addition of 5 per cent. coal-dust. For the top 2 ft. use 47.5 per cent. similar new sand, 47.5 per cent. floor sand, with 5 per cent. coal-dust added, milled lightly or passed through a rotary mixer.

Following this, make another similar casting with the order of the facing sands reversed, *i.e.*, for the bottom 2 ft. use the mixture as used for the top of the first casting, 10 per cent. in place of 5 per cent. coal-dust; for the middle 2 ft. use the new sand without the coal-dust, and for the top 2 ft. use new sand with the addition of 5 per cent. coal-dust.

Notes should be made of the result; the data might be valuable and convincing. The total cost of the above might be 50s. Was it worth it? The total weight of the casting was very little guide regarding the mixture of facing sand required. It was the section of metal, coupled with the depth of casting, that counted.

Habit and Ignorance.

Admittedly, many things performed in a foundry could be explained by the good or even the average moulder. He (the speaker) had spent much time investigating customs in the foundry, and had discovered that previous generations were not so fond of work that they liked to do something for nothing. The requirements of a general jobbing foundry, producing castings of many kinds and sections, were quite different from those specialising in repetition light castings. General foundries produced castings of thin section weighing ounces and castings of thick section weighing tons, hence various grades of facing sands were prepared.

The Appearance of Castings.

The appearance and smoothness of castings counted with engineers, whether their colour be grey, blue, yellow or pink. If coal-dust, blackings, etc., were suddenly discarded, as being unnecessary, then perhaps the complexion of those responsible and those who pay the piper would assume the various colours just mentioned. British moulding sands were equal to any in the world, and when properly manipulated would produce castings of any kind, as good, if not superior, to castings made anywhere. During the speaker's young days, a man was not considered a good moulder unless he could mix the facing sand, blacking, claywash, etc., to suit any job he was called upon to make, whether the preparations were for moulds or cores, in green sand, dry sand or loam.

In connection with facing sands in a general jobbing foundry, it was well to remember the old adage: "It is better to be safe than sorry." Hence it happened that often a mix or grade of sand, with a little coal-dust added, was applied to quite a number of varying sectioned castings.

The Real Issue: How Does Coal-Dust Function?

Referring to the real issue of Mr. Hird's Paper: How does coal-dust function in green-sand moulds when being poured and afterwards? Mr. Smith said that it had been stated that 1 ton of coal could be made to yield 10,000 cub. ft. of gas, 13 cwts. of coke and 10 galls. of tar. These figures might be very illuminating, but would not throw much light on their quest. He desired to face this matter in the simplest possible manner. For a very good reason chemical reactions and deduction would be purposely avoided. The following might be used as a simple illustration:—

If one held an implement, such as a poker, over a burning coal fire for a few seconds, one found it to be covered with a film of tarry substance. When pouring a green-sand mould, with a facing containing 5 per cent. coal-dust, one had to remember that the dust was very thinly and finely distributed. It was added originally to protect the weak or fusible silicates contained in the sand from burning or fusing, either together or adhering to the casting as a crude slag. The tarry carbon-film, which was produced and deposited from the volatiles in the coal-dust by being in contact with the molten metal when pouring, covers to some extent the grains of sand in its close proximity, increasing their resistance to fusion or burning. The gas generated from the more or less incomplete combustion of the coal-dust during this time was not great, and even in tight-covered moulds made its escape quickly. So far as the speaker was concerned, that was all that happened. Coal-dust itself was the opposite to heat-resisting. Little importance only need be attached to coking, balling-up, the cushioning effect of the gases, or the ash from the coal-dust. The effects of these were very small and in practice could be ignored. The presence of carbon in some form might persist with thick-section castings; when the coal-dust content reached 10 per cent. or more, traces might be found in the sand scraped off the castings.

The truth of the old saying, "What is one man's meat may be another man's poison," applied as much to foundry work as to other crafts, and was strikingly exemplified a few years ago, as the following would show:—

Two of the largest founders in the country, situated about 100 miles apart, were each using about 100 tons of new sand per week. In the one case, Erith yellow sand only was used, in the other Notts red sand only was used. The supply to the foundry using the Erith sand was temporarily reduced. They sent to the foundry using the Notts sand, who were producing exactly similar castings, asking for help to tide them over, and received in response several wagons of red sand. At first the result was disastrous, as nearly all the castings made were wasters. The sand was not at fault; it was the manipulation and treatment. The same result would probably have happened if the circumstances had been reversed. Such were the variables in the human element.

Vague Nomenclature of Facing-Sand Mixtures.

The diversity of terms now in use and the necessity for employing a more precise and definite valuation of the constituents comprising sand mixtures was rightly pointed out by the Editor. Simplicity, although highly desirable, would not be accomplished until one obtained more information from the analysis, or composition, of the raw sands; hence it was the duty of the chemist to provide something tangible to work upon, of easy interpretation and more informative.

"Weak," "Medium" and "Strong" were terms applied to bond content, but analysis—neither chemical nor mineral—did not supply all the necessary information. True, the alumina content was generally high when the bond content was high, but it was very little guide to the physical quality, form or evaluation of the bond.

Furthermore, the silica content of a sand as given in the analysis only conveyed a vague idea of its refractoriness or its resistance to heat; it was the purity of the silica that counted. Moreover, it must be borne in mind that these subdivisions of terms were applied in practice, and it had been established that strong sand was required for very thick section castings, not necessarily heavy castings, as such frequently have only comparatively thin sections. Medium strong sand was required for medium thick castings, and weak sand was required for thin section castings. The reasons for this need not now be detailed, unless desired.

Reverting again to coal-dust and the terms superfine, fine, and coarse, the term "fine" is the only one that need to be retained and should represent a certain sieve mesh. The quality of the coal-dust should be guaranteed by the suppliers and it might be occasionally analysed.

"Fat."

The speaker's first association with this term was in the Birmingham district over 45 years ago, and during the intervening period it had not again cropped up until last year, when a student asked the meaning of it. A definition of the term was not easy, but to the best of his recollection it referred to a facing sand containing good bonding properties, *i.e.* sand that easily cohered, finished well with moulders' tools, and stripped clean from the casting. Just as some blastfurnacemen in certain districts, on the pig beds, spoke of "rich" and "common" iron, which means "kishy," high carbon iron, or low carbon and hard iron, in other words, very soft, or very hard, so was the reference to sand made as "rich" or "lean" in fat, *i.e.*, bond. In both cases these terms should be dropped for something better.

Vote of Thanks.

Mr. Cooper moved a vote of thanks to Mr. Smith for his interesting introduction to the discussion. As they all knew Mr. Smith was an expert foundryman and whenever he spoke on any aspect of foundry practice something was to be learned from what he said. He had chosen a subject on which there were varying opinions, and the question of the quality of coal-dust, and the amount to be used, ought to give rise to a very instructive exchange of views.

Mr. A. Jackson, in seconding, remarked that Mr. Smith had done a good service by opening the discussion, and had certainly given them a great deal to think about.

The resolution was carried unanimously.

Mr. Jackson said the question of providing airways was an important one in foundry work, and one point which often gave rise to differences of opinion was, Did the gas leave more quickly from a mould when it was lit than when it remained unlit? Of course that had reference to the amount of coal-dust introduced into the sand. The gas certainly seemed to evacuate much better if there were coal-dust in the sand. The more coal-dust the more flame there was, but the point to be considered was, did it evacuate more quickly in consequence of the presence of the coal-dust? His view was that it did, because if there was no flame there was a certain amount of atmospheric resistance. A flame could not be produced without creating a void, which enabled the gas inside the mould to be liberated more quickly.

If a light casting were being made and the moulder desired to produce a particularly good job, he was apt to put in a quantity of coal-dust in order to make it clean. He had in mind one particular occasion when the casting had to go into the directors' office straight from the mould, and to ensure a satisfactory result much coal-dust was introduced. When he went to look at the casting the following morning, at first sight he thought he had made a blank, because all the teeth were filled almost solid with what appeared to be iron, but which afterwards they were able to clear away. Could

Mr. Smith give them some explanation as to the cause of that occurrence?

A 10 per cent. Maximum Suggested.

Mr. Smith, in reply, insisted that it was a great mistake to put too much coal-dust in the sand. The effect, exhibited by the casting, was the coal-dust actually being eaten into by the metal which, in some cases, was indicated in the form of webbing or mapping.

He considered there was very few facing sands which requires more than 10 per cent. of coal-dust. If the sand were strong enough and correctly mixed one could get a clean skin without introducing a large quantity of coal-dust. Thick castings needed a strong sand and a larger quantity of coal-dust was necessary for green-sand work.

On the question of airways, which were really provided for igniting the gases, he did not think coal-dust assisted very much in bringing away the gas. It certainly did not increase the porosity as many people appeared to think. There was an old-established and firm idea that it made the sand porous. The flame from coal-dust was very small, and he suggested a small experiment. Make a mould, having an 8-in. cube capacity, in open sand with 10 per cent. of coal-dust, and as the metal is poured in slowly a very small amount of smoke will be observed as the metal rises in the mould. That metal would be coking the coal-dust from one grain of sand to another, and there would be produced that protective film which would prevent it from burning or fusing on the casting.

Another point which appeared to be in the last speaker's mind was—Was it better to ignite the gas early on or later? That often depended on circumstances. If one was making a fairly large casting with a big core, which had a large hollow in it, when that casting was quarter or half full it was best to introduce a shot or two of liquid iron. When the proper mixture of gas was obtained it would ignite itself, and there would be no fear of an explosion in the core. As a rule, it was advisable to ignite the gas as the mould was being filled. Some foundry workers objected to that, but if it was done at the right time, and there was the right mixture of atmospheric air and the gases generated in the mould, no ill-effects would follow.

A New Hypothesis.

Mr. T. W. Markland remarked that the use of coal-dust was a big problem. He had read Mr. Hird's Paper and could not agree with all the views he expressed. During the last eight or nine years he had had considerable experience in the application of coal-dust. So far as light castings were concerned, he certainly thought it was necessary up to a point. For instance, with a casting 6 ft. long, 12 in. wide and $\frac{3}{8}$ in. thick, the same kind of sand would not be used for the whole length. The castings would be run with small runners, and where the runner was, the proportion of coal-dust would probably be larger than in the other parts. At the back side of the casting it would be simply black sand. If the coal-dust was correct where the runner was, a smooth casting would be the result, but if the coal-dust was too high at the back side it would be a glazed casting and probably short-run.

Reference had been made by Mr. Jackson to the question of getting away the gas. He thought there was a wrong conception about the gases which came out of a mould. He was open to conviction, but his view was that the flame which arose from a gas when it was lit was not due to the coal-dust. It could be seen even with a dry sand. In his opinion, it was the moisture in the sand, which had been split up into oxygen and hydrogen. If it was in the correct proportions of 2 of hydrogen to 1 of oxygen it came off quietly, but if it was in the wrong proportions, when the gas was lit there would be an explosion. Many people were under the impression that that was due to the presence of coal-dust, but they were mistaken.

Coal-Dust and Light Castings.

Mr. Smith replied that Mr. Markland was apparently speaking from experience, which, of course, was the best source of knowledge. The use of facing sand with coal-dust in one part of the casting where the runners were and black sand at others, was a practical idea. When making heavy castings he had used two or three different kinds of facing sand with satisfactory results. They used to put a strong sand at the bottom and weaken it as it approached the top. In front of the runners there was the wash of the metal, which tended to make it rough unless the sand was properly mixed to resist it.

Mr. J. S. G. Primrose: Can you say anything with regard to my namesake's contribution to the discussion in which he asserted that it was unnecessary to use coal-dust for light castings?

Mr. Smith said it was possible to do so if the castings were sufficiently light and the sand was in good condition but he would not agree entirely with what that gentleman stated. He was open to conviction and it would certainly be better if all classes of castings could be made without coal-dust, but personally he would not like to run a foundry for thick castings without the use of coal-dust in green sand.

Coal-Dust Substitutes.

Mr. J. Masters said it might interest the members to know that there were castings of seven tons weight being made in green sand at the present time without the use of coal-dust. Mr. Smith justified his remarks by suggesting the addition of other carbonaceous matter, such as blacking. In one foundry with which he was very familiar they used "building" sands. A pure silica sand was mixed with a certain proportion of fairly-rich bonded sand and artificial binders, and the results bore out the statement that it was possible to make green-sand castings both in iron and steel without using coal-dust.

Coal-dust was what might be termed an essential for easy working. It had been handed down by their predecessors and held up as an article that could be used very successfully if the moulder displayed some discretion. One of the greatest faults in green-sand moulding was the moisture content. If the correct amount of coal-dust was put into the green sand and properly mixed and the moisture content was properly controlled there would be no trouble. He was not antagonistic to coal-dust by any means, and he had certainly seen some wonderful work up to 20 tons weight in green-sand moulding with the aid of coal-dust.

Continuing, Mr. Masters pointed out that there were many by-products from the coal and other industries of a glutinous nature which were being used successfully in the manufacture of castings as a substitute for coal-dust, and they cut the cost very considerably. They were obtaining a sand which they could manipulate quite easily for green-sand moulding at a lower cost.

Mr. Smith insisted that a casting seven tons in weight was not necessarily a thick one. He emphasised that point in his opening remarks; it was thickness and depth that mattered. Could Mr. Masters indicate the cost of the synthetic sands as compared with ordinary sand?

Mr. Masters, speaking from knowledge of the people who use such sands, said he could say definitely that if there were any increase in cost it would not be done. With regard to the qualities of British sands, he had probably carried out as many experiments with different kinds of sands obtainable in various parts of the British Isles as most men of equal age, and he agreed with Mr. Smith that if British sands were properly mixed there was nothing in the world to surpass them. It was largely a matter of manipulation.

Mr. Smith suggested that Mr. J. M. Primrose added blacking or was liberal with the plumbago bag, which was far more expensive.

A Member described how his firm looked for local excavations and bought sand suitable for the foundry. His experience was that the top portion was always much more open than the lower parts.

Mr. Smith explained that the top stratum was more or less washed during wet weather. The bond was washed out and it entered into the strata lower down, the consequence being that it gave a stronger sand. The top strata in some districts were used for the pig beds at the blast furnaces.

Mr. Hopwood asked whether the casting temperature of the iron used in these various jobs altered. He should imagine that when using dull iron less coal-dust would be needed. Could Mr. Smith say whether some of the difficulties they came up against did not arise from casting when the iron was too hot?

Mr. Smith replied that he suggested a temperature of between 1,300 deg. and 1,400 deg. C. as a basis. The temperature of the iron had some effect on the skin and the cleanliness of the casting. He agreed that dull iron would not need as much coal-dust. The hotter the iron, coupled with the thickness, the more was the tendency to fuse if there were not some protection given to the fusible grains of the sand.

"Sparingly and Good."

Mr. J. Hogg also expressed the view that coal-dust was necessary in green-sand moulding, but he had often wondered whether its advantages outweighed its disadvantages. There was no doubt it was a producer of gas, and he could give numbers of instances to prove that was the case. A short time ago he saw some small wheels, perhaps half a hundredweight each, cast and the result was not satisfactory, although a certain amount of coal-dust had been used. The person responsible for the manufacture, who was a believer in coal-dust, said he could soon alter that and introduced more coal-dust. Twelve castings were made and each one had a hole halfway down the centre of the boss into which a finger could be inserted. That experience led him to the conclusion that where coal-dust was used it should be used very sparingly, and it should be good. (Hear, hear!) He had heard of sweepings from the floor of wharves being put through different-sized meshes and the finest material used for the foundry, the large pieces being resold for fuel purposes. To his mind, that was entirely wrong, because there would be lumps of clay and mud, powdered and other kinds of material, which might be called gritty ash, in the mixture. Anyone using the material as a refractory in green-sand moulding should endeavour to get the fixed carbon content as high as possible. Volatile matter, too, was an important constituent in this refractory. The finest refractory or carbon he had come across was lamp-black, which left a beautiful skin, free from blemish of any kind, but the high cost prohibited its adoption in a commercial form for foundry work. The ash content did not matter so much provided it was not gritty, but a gritty ash was fatal to good moulding. After the carbon content had been taken away, together with the volatile matter and the moisture, the residue was called ash by the metallurgist and the chemist. He had seen a perfectly smooth casting, free from any kind of fault, made from a mould faced with ash separated from a carbon. It was not his intention to condemn coal-dust; if used within reason it was very useful. It was a material which had been adopted for a long time and had proved satisfactory up to a point. Recently he had been wondering what the coal-dust would be like when obtained from the residue after low-carbonisation, and it occurred to him it would be interesting to obtain some of the material from which much of the volatile matter had been extracted for the purpose of making experiments. These matters were all in the melting pot, and finality had not been reached as to the essential character of coal-dust.

Mr. Smith replied that the creation of holes in a casting by adding more coal-dust than was necessary, with the idea of making a clean

skin, was something entirely new to him. His personal opinion was that the volatile matter was more important than the fixed carbon, because they had not reached the point when the fixed carbon was dissociated from coal-dust proper during the casting time. He would, however, not be emphatic or dogmatic upon that point; it was only an impression that the volatiles were really an important factor so far as the action of coal-dust was concerned. If the users of coal-dust desired to analyse the material in order to see whether they were getting value for their money, he did not know of any definite guide, but he should say that coal should approximate to the following proportions:—

Volatile matter	Not under 30 per cent.
Ash	Under 8 per cent.
Sulphur ...	Under 1 per cent.
Moisture ...	Under 5 per cent.
Fixed carbon	Over 50 per cent.

The following was an actual analysis of Durham coal:—

Volatile matter	32.11 per cent.
Ash	5.41 per cent.
Sulphur ...	0.64 per cent.
Moisture ...	3.03 per cent.
Fixed carbon	58.81 per cent.

The coal-dust should be properly prepared and the grinding fineness should approximate to 50, 60 or 70 mesh. It was possible to get it too fine, but certainly it was a serious mistake to use it too coarse. If it was used too coarse with moderately thin castings, shiny specks would be noticeable in the casting.

Mr. Hogg: We are, of course, referring to bituminous coal. Anthracite is not satisfactory for the manufacture of foundry coal-dust.

Coal-Dust from Newer Processes.

Mr. Smith remarked that as regards low carbonisation he agreed it would be desirable to try it, but he doubted whether it would be as useful as the coal-dust used at the present time.

Mr. W. H. Meadowcroft said references to the fineness of the coal-dust reminded him of their visit to Altham coke ovens, where the coal-dust was collected from a settling chamber after it had been drawn off the coal as it passed over the jolting screen. It was a superfine dust, and was used for jobs ranging from a few ounces up to 30 cwts. with a section of not more than 3 in. thick. They had no trouble with it. At the present time they were using a new red Lancashire sandstone, really Ormskirk sand, without manure or anything of that kind, and were getting good results with the addition of 5 per cent. of coal-dust.

To be satisfactory, the dust must be made from a bituminous coal. As far as they could tell from the methods they adopted for testing the coal-dust, the ash content of the Altham product seemed to be very low. His experience had been that it was not necessary to have a coarser grade of dust for castings of heavier section, but of course the work with which he was familiar was done with the Lancashire red sand, and it might be that the result would be different if another sand was used.

At the foundry with which he was connected they made a number of shell rollers, 5 ft. long and up to 6 in. in dia., which were produced in green sand, and it was a surprise to him to find what a tremendous difference a slight variation in the moisture made in the cleanliness and general appearance of the casting. To obtain a good casting it was important to have the sand as dry as possible, so that it would stand up in the ramming. The castings he had referred to were not made in boxes, such as jointed boxes, but were rammed on end and the patterns simply drawn out. Provided the casting was done at a fairly even temperature with about 1 per cent. of coal-dust they came out with a dull blue skin. The thickness of the section in the body was about three-quarters of an inch, and for about 5 in. at each end it was about 2 in. thick. As long as it was possible to get deliveries of new red sandstone, such as Ship Canal or Ormskirk sand, which were very similar, the results were good.

Coal-dust had been handed down to foundrymen for generations past, and if moulders wished to make a specially good job they had to be controlled very closely or they would put an extra amount of coal-dust into the sand and not always with the best results. It was important that they should acquire with more certainty a knowledge of the materials used in the production of castings, and perhaps it was advisable to start with the sands used.

A Simple Scientific Method.

Mr. Smith remarked that Mr. Meadowcroft had a systematic way of mixing his facing sand; he did it by measure. In many foundries it was not always mixed by measure; a barrowload varied considerably—at one time it might be twice as much as at another. With a fairly thin casting which soon solidified a great amount of coal-dust was not required, but 1 per cent. seemed very low.

Mr. Meadowcroft observed that with foundry labourers too much intelligence had not to be assumed. His procedure was this, if they were using 2 of black sand and 1 of red, he had a wooden frame made 12 in. deep and painted black—that was for the black sand. There was another frame 6 in. deep painted red—that was for the red sand. The black frame was filled, the red frame was put on the top and filled, and then a third frame was put on containing the right proportion of coal-dust. In that way fairly even results were obtained.

Mr. Smith remarked that in his young days as a boy they merely trod the material, and he often wondered since how the castings turned out as well as they did.

Gas Action.

The President said reference had been made to the presence of holes due to an excess of coal-dust. There was an explanation of why that occurred, not only from the use of coal-dust but other gas-producing ingredients in the materials. When gas was formed it might be that the porosity or venting of the mould material was insufficient to permit gas to escape quickly. When the metal is poured into a mould a large volume of gas is formed. Before the gases had had time to evacuate through the vents or pores of the sand, the inlet and outlet gates may set, or by the time the gases were evacuated there was not a sufficiently fluid condition in the gates and rises to feed back into the mould. That was an aspect of gases created in the mould which had not been properly understood. With regard to the incident mentioned by Mr. Jackson, the gas probably could not evacuate through the interstices of the mould quickly enough, and that was why he had not got clear cut teeth. Actually, the gas became congested in the teeth and prevented the metal filling the mould.

On the question of the right moment at which to light the gases, as Mr. Smith pointed out, the best course was either to create the flame early on or leave it until definitely the last moment. In certain cases it is very dangerous not to light the gases as soon as formed. He recalled an incident in connection with a large liner weighing 3½ tons. The practice had been to pour shavings inside the interior of the core and light them, thus forming a carbonaceous gas and excluding as much air as possible to commence with, thereby avoiding an explosive mixture. On one occasion this precaution was not taken, and a spark dropped into the combustible mixture and there was a big explosion and the core and mould shattered.

With regard to the addition of artificial binders to sand for casting steel, when he visited the United States some little time ago he noticed in one foundry they were making heavy steel castings in green sand, very open large-grained artificially bonded sand was used. From what he could gather the operation was very successful; the castings turned out remarkably clean and free from the burnt-on appearance which characterises so many steel castings.

Mr. Masters said he should not like the members to think he held a brief in favour of doing away with coal-dust. If he were in charge of a foundry under the conditions obtaining at the present time, and with the handy labour available, he should certainly insist on using coal-dust as a general base for making green-sand castings. His point was that they were just beginning to understand the properties of English sands and special binders.

The functions of coal-dust were to create a refractory film to protect the face of the mould, and that was what it was mostly used for. When a green-sand mould was being cast a film of carbon monoxide and hydrocarbons was formed between the metal and the face of the mould, and as long as that was present the mould was protected, but if it disappeared, or was not sufficiently strong, a fusing on the face of the mould would take place.

Mineral Blacking.

The President said they had been told that mineral blacking could not be used because it was too dear, but that was not always the case. He had found in practice that the additions of mineral blacking to facing-sands could be reduced after a certain period had elapsed when the black sand which was returned to the mill became saturated, necessitating only small additions of the mineral black. At the same time adding a little coal-dust was to be recommended. A mould was much more gas-free when using mineral blacking.

Mr. Smith remarked that in reply to Mr. Meadowcroft's reference to moisture he would advise that under any circumstances the sand should be worked as dry as possible. Many evils could be traced to the use of over-moist sand. The expansion of water to steam was 1,700 times its volume, and one could imagine that unless it was got away very quickly it would have an effect on the casting.

Mr. Jackson remarked that on a previous occasion he referred to the presence of shrink-holes and was advised that there was a possibility they might be produced by coal-dust. He made further investigations and found that some of the shrink-holes were very blue. After testing them out the conclusion come to was that they were probably due to some extent to excessive coal-dust, because they were not the same as the lighter-blue holes caused by dry air in the mould.

Book Review.

Rationalisation for Tin, by A. P. L. Gordon. Published by The Saint Catherine Press, Stamford Street, London, S.E.1. Price 2s. net.

We remember a prominent foundry owner once saying that he did not care a straw what he paid for his raw materials so long as he was certain that his competitors were paying the same price. If that is the general consensus of opinion amongst foundry owners, who, after all, are more important buyers than the book would give one to believe, then the author's message will be thoroughly appreciated. To the metallurgical mind the title of this book indicates such matters as the installation of the best mining machinery, an examination of waste products for ascertaining if they possess any economic potentialities, transport, welfare and so forth, but in this case the subject is confined to the commercial rationalisation. If the author's conception of the word is the same as the reviewer's, the object of the book is to ensure a fair deal for producer, distributor and consumer. The author's solution is both ingenious and interesting, involving as it does the creation of a tin bank and a consumers' association. We imagine that this book will be studied rather carefully by the producing and distributing interests, and we throw out the suggestion that the consumers would be well advised to make themselves *au fait* with the proposals outlined.

Science Hand in Hand with Labour.

By Frank Hudson.

(*Continued from page* 300.)

Moulds and Cores.

It has often been said that the greater proportion of defective castings can be attributed to bad cupola practice rather than to the actual casting and making of moulds and cores. Such a statement is open to very grave doubts, as an unbiased consideration suggests that the greater number of defective castings produced in most foundries is due to poor and badly-supervised pouring and moulding operations. At any rate, this department calls for probably more of the "human element" than any other foundry operation, and consequently is open to mistakes and miscalculations. However, in the last few years the foundryman has had placed at his disposal definite means of controlling several of these variables. Increased adoption of machine moulding, systematic study of sand preparation and handling equipment, efficient drying stoves and sand and core testing and control apparatus have helped enormously to minimise rule-of-thumb methods, and it behoves the practical man to take advantage of these benefits for his own good progress.

The testing of foundry sands and moulds is yet in its infancy, and every credit is due to the American Foundrymen's Association for their work in this direction.

Foundry Sand, Mould and Core Control.

Ideal sands exist for every foundry according to the method of moulding and the class of castings being made. The ideal, however, can never be reached by chance, and only becomes apparent by those who make an attempt to study and test moulding and core sands. The apparatus adopted by the American Foundrymen's Association, or that developed by the author,[5] have been devised essentially to help the practical man, and by their use it is possible to gauge the true value of foundry sands and guarantee successful casting production. On the other hand, sand testing and control paves the way to the elimination of defective moulds and gives a means for correction.

By testing the moulds as described and following the resulting castings through the final stages of manufacture in the dressing and machine shops, it is not a difficult matter to draw up the necessary properties required of a mould and cores for successful casting production. For example, the following specifications have been obtained for brass and grey-iron castings (see Table III).

Moulds having these physical properties will produce satisfactory castings in the hands of skilled moulders, although it should be pointed out that in this specification it would be advantageous to increase the bond strength in order to prevent scabbing and cutting when the sand is worked by unskilled labour.

However, it is essential to have some such specification as this, based on actual practical results, for a starting basis in order to obtain mould and sand control, keeping the facts in mind that, consistent with the necessary sand texture, the higher the bond strength and the greater degree of permeability then the more foolproof becomes the sand for practical application. An ideal sand should have the following characteristics:—

Spherical One-sized Silica Grains.—Spherical grains to give permeability.

A Predominating Grain Size.—Fine for finish, coarse for refractoriness.

Sufficient Bond.—Just sufficient bond coating each spherical grain to give the necessary strength without impairing the continuity of the pore spaces.

A careful consideration of these points by the practical man, and by the use of sand-testing equipment, will supply material for rapid progress, better and cheaper castings, and greater efficiency. Knowledge of the following points, in definite figures, which can be immediately applied to practical application become available:—(1) The effect of sand-preparation machines, (2) the most suitable sand mixture for casting production, (3) the most economical sand can be obtained, (4) sand mixtures to increase production (for instance, self-venting sands), (5) reclamation of old sand, (6) effect of the different moulding methods (machine *versus* hand), (7) elimination of defective castings from mould defects and (8) a working knowledge of the relative values of each moulding sand.

Surely these advantages give more than ample reason for the universal immediate progress of

Fig. 7.—A Compartment of the Stove Battery.

Table III.—*Green Sand Mould Specifications* (*Hand Rammed*).

Brass and Gunmetal Castings (*i.e.*, stop cocks, sluice valves, valve seat rings, sluice faces, hydrants, etc.).

Mixture.	Parts.	Moisture content.	Mould hardness.	Bond strength.	Permeability.
		Per cent.	Lbs.	In.	Seconds.
Belfast red sand	100	7	16–18	1.5	120

Grey Iron Castings (*i.e.*, small sluice valves, standposts, hand-wheels, water meters, sluice frames, etc.).

Mixture.	Parts.	Moisture content.	Mould hardness.	Bond strength.	Permeability.
		Per cent.	Lbs.	In.	Seconds.
Floor sand	8	7	19–22	1.8	80
Drumcavil rock sand ..	4	7	19–22	1.8	80
Wormit red sand ..	3	7	19–22	1.8	80
Coal-dust	1	7	19–22	1.8	80

5 "Scottish Moulding Sands," by F.Hudson, F.T.J., April 12 and 19, 1928.

sand testing, and greater intimate co-operation between science and practice.

Cores.

The adoption of oil-sand cores to foundry practice is one of the biggest benefits to the practical man in recent years, and it is surprising how many foundries do not avail themselves of the benefits arising from their use. The advantages obtainable over dry-sand cores can be stated as follows:—(1) Strength and permeability unaffected by variations in ramming, (2) freedom from scabbing and causing blow-holes, (3) increased production in fettling, (4) lower drying time with decreased coke consumption, (5) increased production, (6) ease of mixing, (7) little volume change after drying, (8) good skin produced on casting without use of blacking, (9) saving in core irons, (10) easily handled after drying and (11) promotes softer skin on casting and lowers machining difficulties.

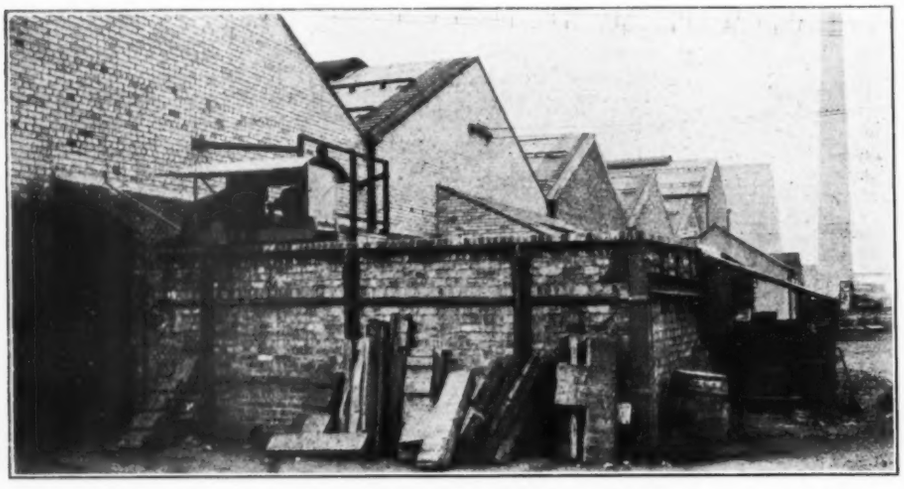


Fig. 8.—General View of Core-Drying Stoves.

Here again, however, the full benefits of oil-sand-core practice can only be obtained by co-operation between science and the practical man. For instance, the number of core oils offered to the foundry trade to-day demands that all should be tested in regard to strength against quantity required and consequent cost of mixture. Different oils require variations in drying schedules and impart entirely different characteristics to the sand mixture when green. For instance, cores which require to be made in halves when using a plain linseed oil—sea sand mixture could be made in one piece by the use of a different oil or by the inclusion of a bonded sand. It would seem, however, that much of the simplicity of oil sand is lost by the inclusion of a bonded sand, as the mixture becomes more susceptible to ramming effects, has less permeability and requires more oil for a given strength. A very great deal of valuable practical information can be obtained by using a modification[2] of the sand-testing apparatus for testing oil-sand-core compositions. In this respect the suggested test methods would consist of tensile, transverse and permeability tests conducted on dried samples, together with a green-dropping test to give an index of the bond strength before drying.

Tensile.—For this purpose use was made of the standard cement mould having exactly 1 sq. in. section across the neck, the resulting test-piece being fitted with the necessary grips so that it could be broken by weighting or by the use of a cement tensile testing machine.

Transverse.—This consisted of a suitable core-box to produce a test-piece 6 in. long by 1 in. square, which was broken by suspending a load from mid-centre from a ¼-in. round shackle, the breaking centres being 4 in. apart.

Permeability.—Conducted as previously described.

Green Dropping Test.—The sand is rammed up in a skeleton core-box on a ¾-in.-thick glass plate to give a bar of sand 12 in. by 1 in. by 1 ft. long. The glass plate projects over the edge of a bench, and the sand is gently pushed over the edge of the plate until the sand collapses. The length remaining (measured from the middle of the fracture), subtracted from the orginal length, is recorded as a measure of the bond, the average of at least four tests being taken.

All test-pieces are dried at 176 deg. C., and a standard silica sand used for mixing. Little trouble is experienced from ramming variations due to the nature of these mixtures, and very concordant test-figures are easily obtained.

Table IV gives an example of the application of such tests to oil-sand compositions. A matter of particular note is the large variations in core strength due to differences in quality of the linseed oil, and the value of these tests for controlling core oil quality are very obvious. Pure linseed oil is derived from the seeds of the flax plant, and it is peculiar that the colder the climate in which the flax plant grows the better the oil seed. As a result the best oil comes from the Baltic, and the worst from India. From these tests it is also interesting to note that mixtures can readily be produced that will give considerable bond in the green condition, which is often of considerable help for certain classes of cores. Within recent years core oils have been added to loam jobs, and as a result less cracking of the mould surface is apparent after drying, and consequent less risk of defective castings.

Loam Mixtures containing Core Oil.

Some years ago the author did some work in this direction, and a mixture found very suitable was as follows:—Milled in light pug-mill: 2 large shovels sea sand, half large shovel floor sand, half large shovel Erith loam, quarter large shovel cow-hair, and 2 pailfuls linseed oil compound. The oil compound consisted of one part water, one part boiled linseed oil, and a very small quantity of ammonia to promote saponification. This was milled for 10 minutes and watered to the correct consistency, when the following results were obtained on the sand-testing apparatus:—

Dried at 176 deg. C. for 6 hrs.—Transverse strength, 1,524 ozs. per sq. in., and permeability 992 secs.

For comparison with the above figures, the following was representative of ordinary stiff fine loam:—

Dried at 232 deg. C. for 4 hrs.—Transverse strength, 511 ozs. per sq. in., and permeability 1,230 secs.

The advantages of the oil addition was an increase of nearly 300 per cent. in strength, better permeability to the extent of approximately 20 per cent., and freedom from drying cracks.

It would appear that the full knowledge and advantages of core-oil use for foundry service has as yet only been touched upon, and the future will see wonderful progress in this direction. The reclamation of old cores and burnt core sand is another important matter. The burnt material makes an ideal parting sand, and can be used to open up green-sand moulds by incorporation with the sand mixture. It can also be adopted by remixing with a suitable core compound for dry-sand facing purposes. Old cores can be passed through a rotary kiln and the oil and carbonaceous matter removed by burning when the product is equal to new core sand. This should receive attention by those founders who have to transport core sand from long distances and carry heavy-freight charges. The matter becomes a practical proposition when freight charges are treble the cost of the sand at the pit.

Table IV.—*Standard Sand Sieve Test (Irvine Sea Sand).*

Mesh No.	20	30	40	60	80	90	100	120
Per cent. passing	96.59	94.01	90.97	77.85	26.89	14.42	9.85	1.72

Strength and Permeability Tests.

Mixture.	Green dropping test.	Tensile strength.	Transverse strength.	Permeability.
	In.	Ozs. per sq. in.	Ozs. per sq. in.	Seconds.
Sea sand—				
2 per cent. boiled linseed oil (Baltic)	1.1	1,921	442	51
Sea sand—				
2 per cent. boiled linseed oil.. ..	—	1,541	732	50
Sea sand—				
4 per cent. boiled linseed oil.. ..	—	4,780	1,918	48
	—	4,502	1,248	52
Sea sand—				
1 per cent. boiled linseed oil.. ..	—	255	105	40
Sea sand—				
2 per cent. pale boiled linseed oil ..	—	11	4	40
Sea sand—				
2 per cent. boiled linseed oil.. ..	—	414	130	46
Sea sand, 40 lbs.—				
Semi-solid core-compound, 2 lbs. ..	2.5	2,722	805	57

All samples baked at 176 deg. C., except green dropping test, which is tested green.

Successful oil-sand practice essentially depends upon the use of good drying stoves. This is a point often overlooked by the practical man. Oil sand dries by oxidation and is not just a question of removing moisture, and the most

successful way to bake cores is by the use of low temperature, with good air circulation inside the stove. In fact, this also applies to drying of all sand moulds and cores in the foundry. One has only to notice how rain-soaked pavements and streets dry just as quickly under the effects of a good breeze without sunshine as on the warmest of calm summer days to appreciate and understand this point. A temperature of 205 deg. C. is amply sufficient to cover the drying of oil-sand cores, and the quickest drying time, with greatest stove efficiency, is obtained by a good inside stove circulation. For this purpose the most flexible practice is to use an exhaust fan instead of the usual smoke stack or chimney. Figs. 7, 8 and 9 illustrate the general lay-out of a stove battery recently re-designed by the author, which has given exceptional satisfaction. The exhaust fan on the roof should be particularly noticed. The general practice is to fire one compartment at a time, whilst the other is being loaded, and after drying has been completed in the one stove the firebox heat is switched over to the next compartment, whilst the exhaust fan has been connected up in such a manner as to withdraw hot air from the stove just finished firing as well as circulating the air in the stove being fired. This results in very quick cooling of the stoves and consequent increased production.

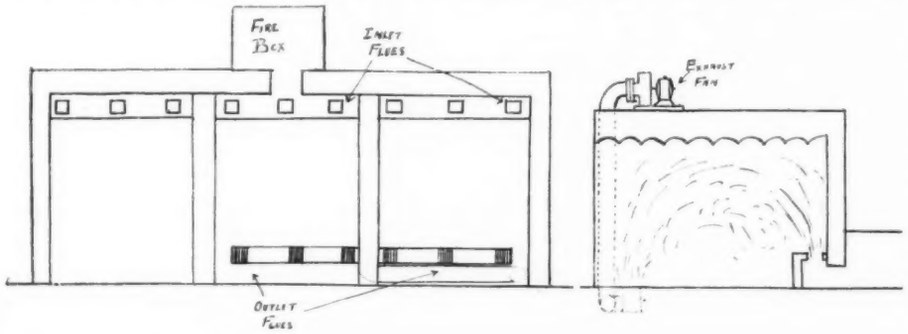


Fig. 9.—Lay-out of Core-Drying Oven.

Fig. 10 shows a temperature-recorder chart from this battery, and particular note should be made of the steady control possible and the saving in time of heating up and cooling down. In this stove a full load of cores can be successfully dried out, up to 3 in. in section, in 2 hours at 176 deg. C. Different core oils require different drying temperatures. For instance, linseed oil can be dried at higher temperatures than those containing molasses or glutrin, and it is of particular importance that a safe drying temperature be employed. Furthermore, to obtain the best results it has been found that for a certain core section the drying time is of importance, and that each section has a certain drying time to give the best and most economical working. For example, in Table V are results obtained on this question, and taking a core of 1-in. section, using 2 per cent. linseed-oil mixture, with a drying temperature of 205 deg. C., the best properties are obtained in one hour. For 1½-in. section the best properties are obtained in 1½ hours, whilst for a 2-in. section perfect drying is obtained in 2 hours. This should be easily remembered, as the drying time is denoted by the thickness of the core section in inches up to 2 in. Work in this direction will give very valuable results to the foundry and save considerable coke and give increased production.

In conclusion, it should be clearly understood that the aim of the metallurgist is to help the practical man, and each should respect the others efforts. The price of safety in foundry work is eternal vigilance, which can only be obtained by suitable control made possible by a mutual understandable basis of "Science Hand in Hand with Labour." The future developments of the grey-iron industry holds untold possibilities, and it is essential that the individual members of the foundry trade should bring themselves and their foundries under the wing of modern progress so that those future developments can be applied to successful practical effort. The author is indebted to the management and directors of Messrs. Glenfield & Kennedy, Limited, Kilmarnock, Scotland, for permission to publish the results in this Paper.

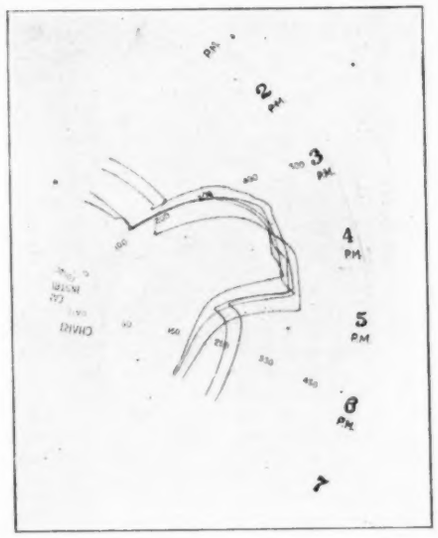


Fig. 10. Temperature-Record Chart for Store Battery.

Table V.—*Core-Drying Experiments at Baking Temperature of 205 deg. C. (Cores made from 2 per cent. Boiled Linseed Oil and Sea Sand.)*

Size of core.	Transverse test in ozs.					
	Baked ½ hour.	Baked 1 hour.	Baked 1½ hours.	Baked 2 hours.	Baked 2½ hours.	
6 in. × 1 in. × 1 in. ..	288	680	648	640	—	Baked 40 mins., 492 Baked 50 mins., 599
6 in. × 1½ in. × 1½ in. ..	—	1,412	1,734	1,720	1,413	
6 in. × 2 in. × 2 in. ..	—	—	1,321	3,236	3,028	

"Norskalloy" Pig-Iron.

Norskalloy is the name given to a Norwegian brand of electric-furnace pig-iron produced exclusively from ores containing a quantity of vanadium and titanium. The pig-iron is available to the following typical analysis in small sand-cast pigs:—Standard: T.C., 4.0 to 4.5; Si, 0.5 to 1.5; Mn, 0.20; S, trace; P, 0.20 to 0.25; V, 0.30 to 0.40; and Ti, 0.40 to 0.80 per cent. Refined: T.C., 2.5 to 3.5; Si, 1.70 to 2.5; Mn, 0.20; S, trace; P, 0.15 to 0.20; V, 0.20 to 0.30; and Ti, 0.30 to 0.50 per cent. It is of some interest to note that in addition to the above constituents careful investigation has shown traces of other of the rarer elements to be present, such as beryllium, while, if required, nickel and chrome can be added.

In all the studies of the addition of special elements to cast iron it has long been realised that the addition of vanadium is especially valuable. Hitherto, the high cost of vanadium in the form of a ferro-alloy has prevented its use in the iron foundry. The new Norskalloy pig-iron offers a cheap and convenient method of making vanadium additions. In re-melting in the cupola, the titanium has the effect of preventing the loss of vanadium, itself undergoing a slight loss due to oxidisation. Norskalloy has a low sulphur content and a phosphorus content sufficiently high to ensure the necessary degree of fluidity and castability for foundry purposes. In use, the addition of 15 to 20 per cent. of Norskalloy to the mixture is recommended for most purposes where vanadium is required.

For grey-iron castings, experimental work has shown that vanadium tends to stabilise the carbide and give improved wear-resisting properties. The combined effort of vanadium together with the titanium remaining after re-melting is recommended as of value in malleable-iron castings. The experimental work already in hand in Germany and the United States is claimed to have such beneficial results as to demand serious attention. Messrs. Bradley & Foster, Limited, Darlaston Blast Furnaces, Darlaston, has undertaken the supply of Norskalloy in Great Britain.

Steel Workers Strike.

About 400 men, employed in Messrs. Fred Braby & Company's steelworks at Springburn, Glasgow, have struck work, unofficially, against the alleged refusal of the employers to introduce certain new conditions which the men claim are operative under the Midland agreement. Some time ago the men by a vote decided to withdraw from the Scottish agreement and to accept the Midland agreement, but now complain that a reduction of 2½ per cent. in wages is the only part that has been operated by the employers. The Iron and Steel Trades' Confederation have advised the men to return to work, as under the Midland agreement it is laid down that all disputes must be settled by methods of conciliation. Until the men resume, the Confederation state it is impossible to have the grievance investigated and adjusted. The men, however, are insistent that their grievances should be remedied before work is re-started. Attempts to bring out other 1,500 employees have so far not been successful.

An extraordinary general meeting of the Dalmellington Iron Company, Limited, was held last Friday for the purpose of considering a resolution to the effect that £91,000, of which £50,000 is from taxation reserve and £41,000 from general reserve, be capitalised and allocated in providing bonus ordinary shares to existing ordinary holders in the proportion of one for three held.

Prerequisites for an Engineering Foundry.*

BRADFORD DISCUSSION PRODUCTIVE OF USEFUL NOTIONS.

The Chairman (Mr. Sayers), in opening the discussion, said Mr. Thornton had dealt with a very important subject and, naturally, had had to touch upon its various aspects in a somewhat superficial manner. One had been accustomed to assume that any engineering undertaking that did any considerable amount of work should find it desirable to do its own foundry work and do it better to its own needs than any outside foundry could do it, but to-day one saw many large engineering shops closing down their foundries. Yet, on the other hand, there were other people enlarging their foundries and sending round circulars that they had surplus capacity and were willing to do work for others on charges based on merely overhead costs. The situation was one of difficulty, and certainly gave the would-be foundry owner food for thought.

Mr. W. H. Poole (Keighley Laboratories, Limited) said Mr. Thornton had very pointedly mentioned one aspect of foundry work which could not be over-stressed, and that was as to the position of the engineer. It was a great pity the engineer could not be in the foundry much more often than he was. If he were, the equipment and conditions in foundries would probably be a great deal better than was the case in many places to-day—perhaps better than even in the best of foundries at present. There were people who declared that if a foundryman were put into a very clean and nicely-equipped place he would quickly make it into a "bogie-hole." Though foundry work was essentially rather dirty work, he (Mr. Poole) thought it was hardly fair to make a sweeping assertion of that kind. Foundry work remained to-day, despite all modern engineering developments, one of the old crafts, and it would be a great pity if the hand-craft aspect would be neglected in the mechanising of foundry work. In regard to the question of purchase of materials, it was rather a pity that the man in charge of purchase was often one who did not know as much about their utilisation as he should. Many a purchase was made by men who had no experience of practical work in the foundry with those materials. Coke was a typical example of purchase on market values at a little supposed economy, which was no economy at all when it came to use in the foundry and was found to give a good deal of vital trouble. In regard to the giving out of foundry work by engineering firms, Mr. Poole said he was afraid the question of quality materials in the manufacture was often not thought about by the purchaser so long as the casting machined easily. Their own foundry might put in a far better metal, which would give better utility results. In reference to foundry design, it was difficult in a short survey such as Mr. Thornton's Paper to give much detail. The sequence of operations, he thought, was often not as efficiently conducted in the foundry as in almost any other phase of production work. Foundries were often built up a little bit at a time, and in such cases unless there was a complete reorganisation the sequence of operations was liable to be defective. So far as concerned design, air and light were very cheap and valuable, but were not utilised by any means so well as they might be. Taking foundries as a whole, they were not nice places to work in for that reason. In regard to purchase and chemical control, if a man had some chemical knowledge—without necessarily being actually a chemist—he could exercise a great deal of valuable control. The chemist undoubtedly could give great assistance to the foundry, even though nowadays one could buy to analysis from the makers if of a reasonable specification, and there was no reason why any foundryman should not have a reasonable analysis of the materials he was buying. If anybody bought materials purely on price, without knowledge of chemical composition, such action was more than behind the times. In regard to the chemist and metallurgist on the works, there was still a need for more tolerance in many works, though undoubtedly the relationships between the chemist and the practical foundryman were steadily improving with growing recognition of each other's particular phase of usefulness. The man with metallurgical training should sometimes restrain himself, and he and the foundry foreman could help each other greatly. The trade could not afford to ignore any knowledge, practical or otherwise, in these anxious days. In the matter of storage space, Mr. Poole said he felt there was a good deal of waste space on many a foundry floor; he might almost say something like an average of 20 per cent. The President had mentioned an interesting point in the question of the economic question of buying castings outside. It was true that to-day some smaller foundries could rather upset matters for a large and well-equipped foundry which had much heavier overhead expenses, and unfortunately a good many of the small men did not seem to have the knowledge of economics to enable them to appreciate the fact that they were tending to cut the throats, not only of the big foundry, but their own as well. Mr. Poole said he was afraid they had a long way to go yet before they could persuade the commercial man that it would be worth his while to spend as much money, proportionately, on the foundry as he would on the remaining portion of his works, but it was up to all foundrymen to do their best in that direction.

The President, replying to Mr. Poole, said in his Paper he had tried to be quite impartial as between one side and another. He had himself had his experience of foundrymen and foundry conditions under a large engineering firm, and now he was having his experience in running an independent foundry. He was glad Mr. Poole had stressed the importance of the craftsmanship of the foundryman. Foundries were being made more and more mechanical, but he could hardly think the craft aspect would be really lost. He hoped the trade would always want the moulder and his craft to give the inspiration for the other work. Mr. Thornton said he entirely agreed with Mr. Poole that the man who used the materials should have more control over the purchase of the materials instead of that being entirely in the hands of a buyer who was chiefly concerned with the financial aspect of the market.

Mr. H. Forrest said he was interested in Mr. Thornton's reference to the position of the laboratory. It certainly should be in a position close enough to the cupola stage to be convenient for work and consultation; but the chemist had only to experience the difference between a laboratory which was separate from the foundry and one built in to realise that the former, in many ways, was well worth while. To his (Mr. Forrest's) mind, too many foundries put the laboratory in a dark corner where the light was not too good and everybody was tramping in dirt and dust. In regard to the life of foundry plant, there seemed to be a good many works managers who could never understand why the foundry crane, for instance, did not give the same length of service as the crane in the engineering shop, but the dust and grit and vibration of a foundry undoubtedly—unfortunate as it may be—shortened the life of such plant considerably as compared with that in the ordinary engineering shop.

Mr. Thornton said, despite the remarks of Mr. Forrest, he still felt that the laboratory should be near the cupola. Anybody who was building a foundry to-day would make provision to cover the objections of dirt, vibration, etc. If the laboratory was far from the cupola, there was a good deal of waste time in consultations between the foundry manager or foreman and the chemist. He certainly favoured the laboratory being in close contact with the cupola—not necessarily the cupola stage—where the instruments could be utilised in the laboratory itself.

Mr. R. D. Welford (Bradford) said Mr. Thornton had covered many points, but one important phase he had missed out of the Paper was that of getting remunerative orders after the foundry was started. Unfortunately, the local foundry trade to-day was in a rather bad way. Mention had been made of engineering shops which had their castings done outside. When they sent out blue prints, they were nearly always able to find somebody who was willing to take the work at an uneconomic price, and that price got the order, though the firm which quoted it may not put the best of material and workmanship into the job. Even to-day there were foundries taking work at an uneconomic price merely to keep the men and plant employed. As to the cleanliness of a foundry, he (Mr. Welford) saw no real reason why the foundry should not be kept as clean and tidy as any other part of the engineering shop. If a man had a clear space for work and had his equipment near him, or in such order that he could get it instantly, he could do quicker and better work than otherwise. He agreed with Mr. Thornton that in building a new foundry many ideals could be incorporated that were not to be found in most foundries at present in existence. Foundries to-day were often the worst lighted and worst ventilated part of an engineering establishment, but he could see no reason why they should not be as well equipped in that respect as the fitting shop. Good ventilation simply meant the employment of an extractor during the night, because, do what one would, the foundry during work was bound to be dirty. Mr. Welford said he thought a good deal of the lack of harmony which had been mentioned as existing between the chemist and the foundry foreman was due largely to lack of technical knowledge on the part of the foreman, who imagined the chemist entered the foundry there to expose his inefficiencies to the management. Personally, he felt that every foundry with an output of 30 tons per week ought to have direct metallurgical control. It would result in better production, and would save the cost in buying. Even if a foreman had technical knowledge, he could only work on the average analysis of his metals as delivered to him, and they varied greatly wagon by wagon, and he could only get an intelligent approximation of what he thought he should have in his casting. Mr. Welford said he felt also that any engineering firm that had an output of 20 to 30 tons per week ought to have its own foundry. Such an undertaking could equip the foundry specially for its own particular work, and could get out its own repairs and renewals more quickly than by having to send out. It could exercise a better supervision over the output of the manufacture, and could see any faults that might occur in the operation of making the moulds, which would not be seen in giving out the work to a strange jobbing foundry. If such a foundry was well managed, it should, he thought, make for itself the profit which the outside foundry would expect to make. Mr. Thornton had given the meeting some excellent ideas of what a modern foundry should be. It was true, unfortunately, that the great majority were not as they should be. There were

* Discussion on the Paper read by Mr. W. G. Thornton before the West Yorkshire Section of the Institute of British Foundrymen, and published in our issue of October 24.

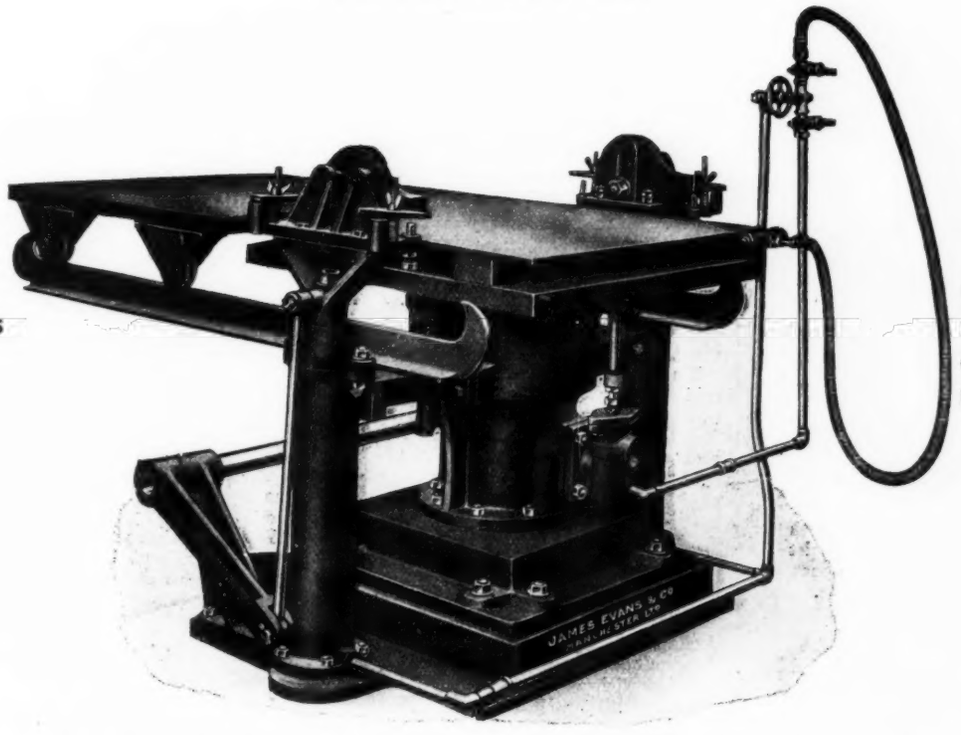
TYPE "C"

JAR RAM MOULDING MACHINE

with Turnover Pattern Plate.

For Pneumatic Power.

TWO MACHINES IN ONE.



UNSKILLED LABOUR ONLY REQUIRED.

The above machine illustrates a Jar Ram Machine with Turnover Pattern Plate which can also be used for Stripping Plate Work.

The machine has been designed to combine the two distinct features above mentioned, and is practically two machines in one, equally suitable for steel, iron, etc.

The machine as illustrated is arranged for work that requires turning over, such as steel moulding. And while the turnover arrangements are intended for general repetition work, by detaching the turnover plate from the trunnion brackets the machine can be used for stripping plate work by attaching the stripping plate to the trunnion brackets. Or, on the other hand, by removing the trunnion brackets as well, the table can be used for jolting general jobbing work.

A very important feature of the machine is the simplicity with which the intensity of the Jolt can be regulated when the operator has become accustomed to the use of the machine, which takes but an hour or so. The valves all being on the exterior of the machine are easily accessible, and there is an adjustable arrangement that will allow the jolt to be varied between 1½ in. to below ¼ in. This being done without disturbing any part of the machine.

The machine is supplied with Withdrawal Carriage, Vibrator, and Blow-off Nozzle complete. It is substantially constructed to stand heavy wear and tear, and requires a minimum amount of skill to operate.

Another important feature of the machine is in the arrangement of the hard wood anvil block for receiving the shock. The blocks being carried well down the machine in a specially designed annular chamber give considerable relief to the foundations. It also provides against the possibility of fracturing the jolting table. Pitch pine blocks are also inserted between the foundation plate and the machine bedplate to assist in the relief on the foundations, and these features considerably improve the working advantages of the machine.

IT IS ALSO ENTIRELY OF BRITISH DESIGN AND MANUFACTURE.

JAMES EVANS & CO. (M/c) LTD.

Britannia Works, BLACKFRIARS, MANCHESTER.

extremes from dark holes, badly equipped, to superfoundries like that of Morris's recently described in The Foundry Trade Journal, but, of course, the latter was highly mechanised and could hardly be regarded as a craft foundry. If all foundries could be as Mr. Thornton had pictured, there would be no difficulty in getting a better type of apprentices into the work, but, as things were in so many foundries to-day, with the spread of education, boys clamoured for a cleaner job than foundry work. If foundry craft could be put on a higher basis, the trade would be on a better level in the engineering trade. The present position, he believed, was largely a result of a lack of self-respect among foundrymen of the past, many of whom must be admitted to have been excellent craftsmen, even though often lacking in general education. That time was passing, and, with the younger generation coming along, he believed there would be much more toleration between the practical side and the technical side in foundry work.

Mr. A. S. Worcester (Vice-President, Huddersfield) said one of the first considerations for anyone starting a foundry was the nature of the production, but he was afraid few men to-day were likely to be able to stand the cost of having the plant and equipment they would wish. When they considered the hard wear and tear on foundry plant and that they would probably have to depreciate to something like 30 per cent., the opener of a new foundry would probably find that he would have to cut out a good deal of the proposed equipment, and he believed the present cost of installing and equipping a foundry would frighten most people. As to the site of a new foundry, it was very rarely one could get a truly flat piece of ground—at any rate in West Yorkshire—but there was ample opportunity to utilise the varying levels of the ground in such a plant. The matter of artificial lighting, of course, depended largely on the nature of the work. His (Mr. Worcester's) experience was that the bulb electric lighting was by far the best, and far better than the arc lamps. The differences between chemist and foreman seemed to him to be more a matter of the personal element than anything else. Fairly accurate analyses are available from the makers for most jobs to-day without the assistance of the chemist, but the help of the chemist was very desirable in regard to sands and many other factors apart from the iron or the coke alone.

Mr. Thornton said he agreed with Mr. Worcester that the cost of setting up the ideal plant was rather prohibitive to-day. It was, of course, no use buying any plant that was not likely to pay its way, however desirable it might be from an ideal form of view. Mr. Thornton agreed with Mr. Worcester that the personal element was largely at the root of trouble between the chemist and the foundryman, and it was quite true that the pig-iron and the coke were quite a small thing compared with all that the metallurgist could do in a foundry.

Mr. Poole, speaking of costs, said one of the difficulties for the foundry manager was that his working was usually burdened with a proportion of the general overhead charges of the engineering works. He felt that the engineering works foundry had a much better chance of competing with outside foundries if it was costed entirely on its own basis.

The President said he had had experience of both aspects of foundry work. It was, of course, a debatable point as to whether the foundry of an engineering works should or should not bear some share of the general costs of establishment, advertising, travellers, etc., from which expenditures, presumably, it derived some benefit. From the foundry point of view there was no doubt about it that the accounts of a foundry which were independent of the remainder of the works were much more satisactory—though there may be occasions on which some engineering repairs in the foundry would be cheaper to the foundry if done in with the works costs generally than if charged separately against the foundry.

Mr. L. Farrar (Shipley) thought it was desirable, especially in starting a new foundry, to make some arrangement for manufacturing some stock, so that the regular and experienced men, used to the particular requirements of the firm, might be kept employed when orders were few. One of the worst features of foundry life, to his mind, was the labour turnover. Sometimes, he agreed, it was wise to introduce new blood, but not to the extent of constant change. Newcomers brought new ideas and ways, to the advantage of the shop, but he felt it was a wise provision in starting a foundry to arrange means to keep the best hands employed and available when needed for orders. Everybody recognised, of course, that if a foundry was in connection with an engineering shop it must be built to suit the particular requirements of that shop.

Mr. J. J. Watson (Huddersfield) thought one of the most desirable needs in a modern foundry was provision for the men to wash and change from their dirty clothing to go home reasonably clean. This was particularly important with the growth of modern passenger transport, in which the foundryman had to mix with people who were in good clothes and had to travel, very often, in nicely-appointed motor omnibuses, etc.

Mr. Poole said that was largely a matter of gradually educating the workmen themselves to appreciate such facilities when provided. He had recently visited a foundry in which there were excellent facilities for the cleansing of the men after the day's work, but these facilities did not seem to be much used.

Mr. S. W. Wise (Hon. Secretary, Bradford) said the question of tackle in a new foundry was a very vexed one, particularly if it was a foundry attached to some other works. It must be borne in mind that when a firm of engineers set out to build a foundry the foundryman had to cut down his requirements as much as possible, but if he set forth the ideal outfit he would be told he must make do with less until he got going, and then he would probably have to work with improvised tackle. Mr. Wise thought the question of management, and of the practical man and the chemist, was not perhaps so vexed as would sometimes seem. Personally, he had worked for years in conjunction with a chemist and he had experienced little difficulty. If each had a proper respect for the other's training and experience they could go a long way together, and if the chemist and foundryman were to get any real help from one another they must work very closely and intimately together rather than through any third party. In regard to market prices for product to-day, Mr. Wise thought the cutting of the present time was due largely to the sharpness of buyers and their bargaining down to a cut figure and playing one foundry up against another. As to cleanliness, he thought it must be agreed that better work was to be expected from the clean and tidy foundry than otherwise. Mr. Wise said he remembered one place where the firm provided hot baths for the men, but the men were charged a penny each for them and they were very little used. There was no doubt a good deal of risk of misuse and even damage where good sanitary and cleansing facilities were provided, but this was no worse in the case of foundrymen than of most other classes of workpeople. There was not much to be gained by improving the men's environment in that direction unless one could interest the men themselves, and that was largely one of the objects of the Institute of British Foundrymen.

The Chairman (Mr. Sayers) said it was time they got away from the "inferiority complex" of the moulder. Better cleansing facilities had been spoken of, and it had been suggested that the men would not use them. Let the industry, at any rate, do its best to give the men the better facilities, and he believed the better education of the rising generation would put these things into better use, all to the benefit of the foundry industry and those who had to earn their livelihood in it.

Mr. W. Parker (Halifax), proposing a vote of thanks to the President for his address and his subsequent Paper, said one of the things that occurred to him many times was that the people who supplied machinery and plant for the foundry seemed often to be about the last people in the world to give the foundryman the best guidance as to how to use it to the best advantages. That was a great failing in modern devices for helping the work along. They simply put the machine down, after saying "So-and-so is using it," and left the foundryman to make the best of it as he thought fit, whether he had had any experience of such a machine before or not. This no doubt made engineers who desired to make a good place rather hesitant about installing further plant.

Mr. L. T. Wright (Gomersal), seconding, said one of the greatest reasons for difficulties in the foundry was the lack of direct contact of the employers themselves—he was speaking of an engineering undertaking, of course—with the work in the foundry. The young man who rose to be the head of an engineering firm, probably the son of a director, was probably given an excellent training in the various phases of work in the engineering shops, but very little, if any, training in the work of the foundry, and he came in due course to be the controlling head of an undertaking, with an important foundry side of its operations, without any knowledge whatever of foundry problems. Foundry work seemed still to be too often looked upon as of a lower status than any other department. Mr. Wright said he felt that Mr. Thornton's Paper could be given to a meeting of engineering employers, with considerable benefit to the foundry industry and to the employers.

Mr. Kirkbride (Shipley) supported the vote of thanks, which was carried unanimously.

Mr. Thornton, in response, said he quite agreed that it was unfortunately true that the average engineer's son was taken into the drawing office and the general engineering side and was allowed to rise to the proprietorship or directorate absolutely devoid of any foundry knowledge.

Falkirk School to have a Foundry.

At Falkirk Dean of Guild Court, on October 24, plans were passed for the erection of an advanced central school at a cost of £80,000. The new building will have accommodation for over 600 advanced division pupils and will occupy a site of seven and a-half acres, The main building will contain a large central hall, administrative offices, laboratories and technical rooms, and the school classrooms built so as to derive the maximum of light. At the rear is to be built another large building for technical purposes, the eastern wing of which will be devoted to workshops, a miniature foundry, with moulding shops, patternmaking rooms and a foundry laboratory. Two mechanical engineering shops will also be installed in this portion. The plans have been prepared, under the direction of Mr. A. N. Malcolm, by the works department of the Stirlingshire Education Authority.

The English Electric Company, Limited, have received a contract from the South Indian Railway Company for the rolling stock required for the electrification of the Madras suburban services. The order comprises 17 three-coach articulated units, each unit consisting of three all-steel coaches, together with the necessary electrical equipment. In addition, there are four electric goods locomotives. The total value of the contract is about £170,000.

Aluminium
ALLOY INGOT
VIRGIN NOTCHED BAR

"Y" ALLOY

Aluminium Data Sheet A129

F.T.J. 1.11.29

This alloy, composed of 4% Cu, 2% Ni, and 1½% Mg, the balance being aluminium, was developed by the National Physical Laboratory as the result of a search for a light alloy which would retain its tensile strength at comparatively high temperatures. It belongs to that type of alloy which attains specially high mechanical properties by virtue of a form of heat-treatment. It is used as a casting alloy, and also for forging. Castings should preferably be made in metal moulds because the effect of the heat-treatment is more pronounced on the compact metal structure obtained in a chill mould. Typical properties of the chill cast alloy, before and after heat-treatment, are as tabulated :

Property	Chill Cast (as cast)	Chill Cast (Heat-treated)
Density	2·79	2·79
Yield point, tons per sq. in.	10·0	14·5—16·5
Ultimate strength, tons per sq. in.	11—13	17—22
Elongation—%	1—2	3—6
Brinell Hardness No.	85	105
Izod impact test, ft. lbs.	—	3—5
Fatigue range, tons per sq. in. (20×10^6)	—	7
Modulus of Elasticity, lbs. per sq. in. ($\times 10^3$)	10·9	10·8

The heat-treatment of 'Y' alloy consists of heating the casting to a temperature of 500-520° C. for a period of not less than six hours, followed by quenching in boiling water. After seven to ten days ageing at room temperature, the material develops its full mechanical properties. The ageing can be accelerated, however, by boiling the castings in water for two hours. *(continued)*

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VOLATILE	,, ,,	1 %
MOISTURE	under	1·50%

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Trade Talk.

The employees of Messrs. William Simons & Company, Limited, Renfrew, have contributed the sum of £177 10s. to infirmaries and other charities.

The Ebbw Vale Steel, Iron & Coal Company, Limited, removed their London office on Monday last, October 28, from 1, Victoria Street, to Kinnaird House, Pall Mall East, S.W.1.

Three of the leading Czecho-Slovak ironworks have decided to fuse their interests. The Skoda, Ceskomoravska and the Brünner Waffenfabrik and their subsidiary companies are principally concerned.

Messrs. Thomas Smith's Stamping Works, Limited, Coventry, have acquired from the receivers of Clayton Wagons, Limited, Lincoln, the whole of the assets of the Clayton Forge as a going concern.

Sunderland Rural Council have approved of plans submitted by Messrs. T. S. Forster, Limited, of Pallion, for the erection of a forge at South Hylton on the site of the old works of Messrs. Reay & Usher, Limited.

Messrs. C. A. Parsons & Company, Limited, Newcastle-upon-Tyne, have received an order from the Northern Provinces Electricity Company, Holland, for the supply of two 30,000-kw. turbo-alternators and condensing plant for their new station at Ymuiden.

Messrs. Vickers-Armstrongs, Limited, Barrow-in-Furness, have received a contract for the machinery for a large cement plant in the Far East, namely, the Green Island Cement Company, Limited, whose new works will consist of two units, each having a capacity of 1,000 tons of cement per week.

Messrs. John G. Kincaid, Limited, Greenock, have obtained contracts to provide the machinery for two oil tank vessels being built by Messrs. Swan Hunter & Wigham Richardson, Wallsend-on-Tyne, for Messrs. C. T. Bowring & Company, Limited, Liverpool. The engines will be Kincaid-Harland B. & W. eight cylinder, single acting.

It has been resolved that the name of the amalgamated concerns of John Baker & Company (Rotherham) (1920), Limited, and Henry Bessemer & Company, Limited, Sheffield, makers of railway material, shall be John Baker & Bessemer, Limited. Recently the joint concerns have participated in a good share of orders, one order being for 5,300 tyres for the South African railways.

The annual festival dinner of the Royal Metal Trades' Pension and Benevolent Society is to be held on December 4. Mr. Neville Chamberlain, M.P., will preside. The Society is making an appeal for funds. Mr. A. K. Steven, chairman of the Board of Management, states that to give adequate relief to the pensioners and applicants £4,000 is required for the current year.

Messrs. Kerr, MacLeod & Macfarlan have reported to the joint secretaries of the Board of Conciliation for the Regulation of Wages in the Pig-Iron Trade of Scotland :—"In terms of the remit, we have examined the employers' books for July, August and September, 1929, and have certified that the average net selling price is £3 15s. 4d." This means that the wages of the workmen will be increased by two per cent. on basis rates.

Members of the Glasgow and West of Scotland Association of Foremen Engineers and Draughtsmen recently visited the works of Messrs. G. & J. Weir, Limited, at Cathcart. They were conducted through the various departments and were shown some examples of modern machine tools in operation. In addition they were shown, among other products, a number of turbine feed pumps constructed for export to Germany, and samples of mass production.

The Dublin Dockyard Company (Vickers, Ireland, Limited), have received an order from the Sligo Steam Navigation Company, Limited, for a new steamer for the Liverpool-Sligo cattle service. She will be 220 ft. long with 35 ft. beam, and will be propelled by two sets of triple expansion engines. Messrs. A. Guinness, Son & Company, Limited, have also placed orders with the Dublin Dockyard Company for two more self-propelled river barges of the most recent type.

Messrs. A. & J. Inglis, Limited, Pointhouse, Glasgow, launched the twin screw motor ship "Amberes," which they have built for the Argentine Navigation Company (Nicolas Mihanovich, Limited), of London and Buenos Aires. The vessel is the first of four sister ships now being constructed, two by Messrs. Inglis and two by Messrs. Harland & Wolff, Limited, Govan, and is 275 ft. in length, 43 ft. in breadth, and of 1,500 tons gross. The propelling machinery, consisting of two six-cylinder, four-stroke trunk type engines, of the Harland B. & W. type, aggregating 900 i.h.p., will be supplied by Messrs. Harland & Wolff, Limited, Glasgow. Messrs. Inglis have already laid the keel of their duplicate vessel.

Several important shipbuilding contracts have been booked recently by yards on the North-East Coast. Messrs. Robert Thompson & Sons, Limited, Sunderland, have received an order to build two vessels of 8,000 tons for London owners. The engines are to be built by the North Eastern Marine Engineering Company, of Wallsend. Messrs. John Readhead & Sons, Limited, South Shields, have received an order for two similar vessels for the same owners. Messrs. Swan, Hunter & Wigham Richardson, Limited, Wallsend, have booked a contract for two motor tankers for Liverpool owners and a motor tanker for Mr. A. A. Rapp, of London. Messrs. R. & W. Hawthorn, Leslie & Company, Limited, Hebburn, have booked an order for a salvage tug for the New Zealand Government.

Messrs. T. W. Ward, Limited, have purchased for dismantling the Atlantic Transport liner "Minnesota," and the vessel is to be broken up at Inverkeithing. The vessel has a gross tonnage of 11,905. Originally named the "Zeeland," she was built by Messrs. John Brown & Company, Limited, in 1900, and then had accommodation for 1,100 passengers and excellent deck machinery for the rapid handling of cargo at terminal ports. During the war she was commissioned as a transport and helped to carry the first great Canadian Expeditionary Force to Europe. In the summer of 1916 she was requisitioned under the Liner Scheme and had several narrow escapes from being torpedoed. After the Armistice she was modernised and converted to oil fuel and returned to the New York service. At the beginning of 1927 she was re-named "Minnesota," to run alongside the "Minnekahda" on the Atlantic Transport Line's service between London and New York.

Sir Robert Donald, addressing the members of the Incorporated Sales Managers' Association recently, said that Canada possessed more undeveloped wealth than any country in the world, and was now entering upon an era of unexampled prosperity. In total trade Canada ranked fifth among the nations and, taken on a *per capita* basis, it occupied first place. Britain was not getting her fair share of this turnover, and it was up to manufacturers in this country to get back and maintain their export trade with Canada. They could overcome the proximity of their competitors if they went the right way about it. Let more principals visit Canada. Recognise that the commercial language of Canada was that of the United States, as were also their business methods and their professional, business and labour organisations. The British manufacturer should not let his agent in the United States control his business in Canada. The Canadian resented bitterly the policy of treating Canada as an economic annexe of the United States.

The British Steelwork Association has now been registered as a company limited by guarantee, not having a share capital, with an unlimited number of members, each liable for £1 in the event of winding-up. The word "limited" is omitted from the title by licence of the Board of Trade. The objects of the Association are to promote and develop the production and use of structural steel and steelwork and structural iron and ironwork, etc. The registered office is at Artillery House, Artillery Row, Victoria Street, London, S.W.1. The management is vested in a council, the first members of which are :—W. T. MacLellan (chairman and managing director of P. & W. MacLellan, Limited); E. Boynton (agent and London manager of Sir William Arrol & Company, Limited); W. R. Gilbert (assistant director of Dorman, Long & Company, Limited); J. H. Humphryes (chairman of Braithwaite & Company (Engineers), Limited); A. S. Spencer (general manager of Heenan & Froude, Limited); J. D. Stitt (director of Redpath, Brown & Company, Limited); E. A. Willson (managing director of Archibald D. Dawnay & Sons, Limited); A. Dorman (managing director of Dorman, Long & Company, Limited); J. Craig (managing director of David Colville & Sons, Limited); W. G. Gray (managing director of the Steel Company of Scotland, Limited); H. B. Jacks (sales manager of Baldwins, Limited); J. E. James (director of the Cargo Fleet Iron Company, Limited); A. Veitch (commercial manager of the Frodingham Iron & Steel Company, Limited); B. Walmsley (director of Boickow, Vaughan & Company, Limited).

Personal.

Mr. Kendall Park has been nominated a director of Messrs. Guéret, Llewellyn & Merrett, Limited.

Mr. R. C. Stanley and Mr. W. B. Lawson, of the International Nickel Company of Canada, Limited, have been elected directors of Messrs. Henry Gardner & Company, Limited.

Mr. K. O. Keller, general manager of Messrs. William Doxford & Sons, Limited, shipbuilders and engineers, Sunderland, has been awarded the gold medal of the North-East Coast Institution of Engineers and Shipbuilders for a Paper on marine oil engines.

Mr. S. L. Bengtson, of the International Construction Company, London, who has been appointed consulting engineer on the new iron and steel plant to be erected at Pretoria, South Africa, by the South African Iron & Steel Corporation, arrived in New York on October 22. He intends to visit the various American steel centres.

Wills.

Morrison, R. A., late secretary of Stewarts & Lloyds	£11,404
Kennard, R. W., late chairman of Falkland Iron Company	£39,452
Sartoris, L., late chairman of the Kettering Iron & Coal Company, Limited	£19,686
McLaren, H., chairman of Messrs. J. & H. McLaren, Limited, engineers, Hunslet, Leeds	£19,214

Reports and Dividends.

Drake & Gorham, Limited.—Net profit, £8,220; brought in, £3,570; dividend of 5 per cent.; to general reserve, £2,500; carried forward, £3,040.

George Turton, Platts & Company, Limited.—Profit, £4,446; brought in, £7,372; dividend of 5 per cent. on the ordinary shares; carried forward, £4,420.

Samuel Osborn & Company, Limited.—Profit, £44,301; brought in, £13,418; dividend of 7 per cent. on the ordinary shares; to reserve, £5,000; carried forward, £21,945.

Millom & Askam Hematite Iron Company, Limited.—Net profit, £65,112; brought in, £39,818; provision for new blast furnaces, £20,000; carried forward, £35,930.

William Beardmore & Company, Limited.—Trading loss for 1928, £31,195; interest charges, £37,910; provision for reconstruction expenses, etc., £216,540; total debit on profit and loss account, £817,745.

Stothert & Pitt, Limited.—Profit, £35,204; brought in, £4,726; preference dividend, £3,191; to reserve, £7,000; to income-tax reserve, £6,000; written off freehold premises, £3,000; dividend on ordinary shares of 10 per cent.; carried forward, £5,411.

Parsons Marine Steam Turbine Company, Limited.—Profit, £22,344; transferred from taxation account, £50,000; brought in, £33,825; dividend of 10 per cent., tax free, absorbing £21,128; special bonus of 25 per cent., tax free, £52,820; carried forward, £32,221.

Contracts Open.

Ewenny, near Bridgend, November 18.—Pumping station and ancillary works, for the Mid-Glamorgan Water Board. Messrs. Thomas & Morgan & Partners, civil engineers, Pontypridd. (Fee £10 10s., returnable.)

Johannesburg, December 5.—Vacuum and steam pressure gauges, for the South African Railways and Harbours. The Department of Overseas Trade. (Reference A.X. 8,701.)

London, W., December 13.—Pumping plant, for the Acton Borough Council. Mr. W. G. Cross, borough engineer, Municipal Offices, Acton, W.3. (Fee £2 2s., returnable.)

Rumney and St. Mellons, November 1.—8,500 yds. of 3-in. dia. cast-iron pipes, for the St. Mellons Rural District Council. Messrs. Thomas & Morgan & Partners, engineers, Pontypridd.

Toronto, November 5.—Centrifugal pump and electric motor, for the Department of Works. The Department of Overseas Trade. (Reference A.X. 8,703.)

Wareham, November 16.—Four centrifugal pumps and electric motors, for the Town Council. Mr. W. E. Blizard, Castle Lane, Southampton. (Fee £2 2s., returnable.)

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MONOLITHIC LININGS

Mr. H. C. ELLIOTT, in a recent paper on this subject reprinted in "The Refractories Journal" for August (page 363) says:—

"A monolithic lining is designed to take the place of firebrick.

"Good firebricks are obtainable, but a firebrick lining is dependent entirely on the joints and no matter how carefully the bricks are laid, the joints usually break down before the bricks, and this results ultimately in bre: king down the bricks."

We wish to make it emphatically clear that "PYROLYTE" the cold hard setting infusible fire cement has solved for all time the problem of weak joints.

A "Pyrolyte" Joint is the ***strongest*** part of a lining.

It outlasts the firebricks and sets, without heat, so hard that a knife point will not penetrate it.

A sample cwt. of "Pyrolyte," the cold setting fire-resisting Portland Cement, may be obtained carriage paid in a free water and airtight steel drum with a screw lid, for 30/- Nett Delivered.

Descriptive booklet free on application.

Iron and Steel Markets.

Pig-Iron.

MIDDLESBROUGH.—Attendance at the weekly markets for Cleveland iron of late have been steadily diminishing in numbers, and this week's meeting of the members has been no exception to the rule. The tone throughout has developed an apathetic tendency, implying a general lack of confidence in the stability of the present position of the industry. Buying on forward account has now become increasingly limited. Consumers are hesitant, regarding the outlook as too uncertain to venture beyond immediate requirements, with the result that markets continue stagnant as contrasted with normal activity. One positive fact to be faced is that foreign competition is becoming keener. Cleveland can never regard the loss of foreign markets with complete equanimity, and still less when foreign iron is again coming into the Tees to compete with the local product. Despite the conditions thus outlined, the Cleveland ironmasters adhere to their fixed minima, and only a few small transactions through merchants have been put through at slightly below the fixed quotations, which are:—No. 1 Cleveland foundry iron, 75s. per ton; No. 3 G.M.B., 72s. 6d.; No. 4 foundry iron, 71s. 6d.; No. 4 forge iron, 71s. per ton.

The position in the East-Coast hematite trade is still fairly satisfactory, many furnaces being well sold over the next few weeks, and with substantial contracts on their books the makers have been successful in raising the market price of mixed numbers to 78s. per ton. But French hematite is competing keenly in neutral markets, and at home there are still holders who have considerable stocks. However, the general quotation for mixed numbers is now 78s. per ton and No. 1 quality is at 78s. 6d. per ton. On the North-West Coast the price of Bessemer mixed numbers remains at 77s. per ton at works.

LANCASHIRE.—In the local markets for foundry pig buying interest has been on the quiet side, and in the aggregate fresh sales have not amounted to any big tonnage. On the whole, the demand for deliveries of pig-iron locally against existing contracts shows no sign of falling-off, and sellers are reasonably well satisfied with the position in this respect. With regard to prices, offers of Staffordshire and Derbyshire No. 3 iron are at 77s. per ton, with Scotch brands firm at from 92s. 6d. to 93s. 6d. per ton, delivered.

THE MIDLANDS.—The ironfounders in the South Staffordshire and Birmingham area continue to be well situated for work and are specifying for good supplies from the furnaces against earlier bookings. Prices remain firm as follow:—No. 3 Northants, 75s.; No. 3 Derbyshire, 78s. 6d.; No. 3 North Staffs, 79s. 6d., all per ton, delivered local stations.

SCOTLAND.—A very limited business has been done in Scotch pig-iron this week, but steady deliveries are being taken against existing contracts. There is no change in prices, which remain firm on the basis of 76s. for No. 3 Scotch foundry, f.o.t. furnaces.

Finished Iron.

At Birmingham this week demand for iron bars of crown and cheaper grades is on a very restricted scale. There is nothing near sufficient business developing to keep the forges fully occupied. Prices are variable, and anything from £9 15s. to £10 5s. is quoted for Staffs crown bars, while £9 12s. 6d. is offered from other districts. Nut and bolt iron is quoted at £9 and upwards, but with very little chance of success because of the domination of the market by foreign bars at much lower prices. One satisfactory feature is the continued support for Staffordshire marked bars at £12 10s. at works. In this direction the works are very well occupied.

Steel.

At Sheffield this week a rather more encouraging tendency in the market for steel was observable, probably as a result of a number of important orders from both home and abroad which have been placed with local firms during the last week or two, and which will to some extent minimise the dislocation caused by the curtailment of armament orders. Buying is a little better, mainly of basic billets, which do not appear to be suffering very severely from the Continental competition. Siemens acid billets, however, show hardly any recovery, the demand being very poor. There is fairly substantial buying of wire rods. Soft basic billets are not obtainable at less than £7, and hard qualities are at from £7 12s. 6d. to £9 12s. 6d. per ton. Siemens acid billets remain at £9 10s. In the tinplate market, the general tone may be termed quietly steady, and quotations firm as follow:—Coke quality, 19s. basis and upwards, net cash, f.o.b. Welsh ports.

Scrap.

A steady moderate demand is still current in the principal markets for foundry scrap material, and on Tees-side the foundries are fairly busy, but appear to have covered the bulk of their needs. Ordinary foundry grades of heavy cast iron continue to be quoted at 66s. 6d. and good machinery quality at 68s. 6d. per ton. In the Midlands, there is a fairly good demand for machinery cast-iron scrap at 70s. delivered to the local foundries. Ordinary heavy cast-iron scrap is at 65s. and light cast iron at 60s. In Scotland, business in this market continues quiet, with prices almost stationary, first-quality machinery metal, suitable for foundries, being quoted at 70s. to 71s. 3d., and ordinary cast iron at 64s. to 65s. Steelworks cast iron is at 62s. 6d. to 63s. 6d. Old cast-iron railway chairs are unchanged at 67s. 6d. to 68s., light cast iron at 60s. to 61s. 3d., and old cast-iron firebars at 58s. 6d., all per ton delivered works.

Metals.

Copper.—Movements in warrant copper over the past week have been on a comparatively quiet scale, values having been fairly well sustained, with only slight variations from the levels ruling during the month current. In regard to the future, much depends on the attitude adopted by Copper Exporters, Incorporated. They undoubtedly have it in their power to maintain the price of electro at the present level, but they may elect to take the longer-sighted alternative of reducing the figure to a more economic level.

Closing quotations are:—

Cash.—Thursday, £72 7s. 6d. to £72 10s.; Friday, £72 1s. 3d. to £72 2s. 6d.; Monday, £72 2s. 6d. to £72 3s. 9d.; Tuesday, £71 5s. to £71 6s. 3d.; Wednesday, £70 6s. 3d. to £70 7s. 6d.

Three Months. — Thursday, £72 15s. to £72 16s. 3d.; Friday, £72 8s. 9d. to £72 10s.; Monday, £72 2s. 6d. to £72 3s. 9d.; Tuesday, £71 5s. to £71 6s. 3d.; Wednesday, £70 6s. 3d. to £70 7s. 6d.

Tin.—The market for standard tin continues with an irregular tendency in values, quite difficult to understand from a cursory examination of the statistical position. These conditions may probably prevail for some time to come, but the statistical outlook, on the whole, is sufficiently favourable to justify a moderately optimistic view, instead of the pessimism which has led in recent weeks to wide liquidation and consequent irregularity.

Official closing prices:—

Cash.—Thursday, £188 15s. to £189; Friday, £186 15s. to £187; Monday, £183 10s. to £183 15s.; Tuesday, £184 5s. to £184 10s.; Wednesday, £184 5s. to £184 10s.

Three Months. — Thursday, £192 17s. 6d. to £193; Friday, £190 15s. to £191; Monday, £187 10s. to £187 15s.; Tuesday, £188 5s. to £188 10s.; Wednesday, £187 10s. to £187 15s.

Spelter.—In regard to this metal, Messrs Henry Bath & Son, Limited, report that there has almost daily been considerable selling by Continental interests against their stocks. A slightly better trade demand has been seen, both in this country and on the Continent, but the galvanisers are at the moment inactive and there seems to be little chance of any improved demand from that quarter.

Daily quotations are:—

Ordinary. — Thursday, £22 10s.; Friday, £22 12s. 6d.; Monday, £22 2s. 6d.; Tuesday, £22; Wednesday, £22 1s. 3d.

Lead.—Buying in the market for soft foreign pig has, of late, been on a restrained scale, with only small fluctuations in price. Consumption has been fairly well maintained, but the low price of spelter is causing considerable anxiety to the lead paint makers. The price of zinc is still below that of lead.

The week's prices have been:—

Soft Foreign (Prompt).—Thursday, £23 11s. 3d.; Friday, £23 12s. 6d.; Monday, £23 7s. 6d.; Tuesday, £23; Wednesday, £22 7s. 6d.

Students' Corner.

Q.—How can liquid contraction be explained or demonstrated?

A.—If three 12-inch cubes be poured open-sand, such behaviour can be verified, as the liquid shrinkage can be roughly measured. One cube is poured with a No. 1 grade of iron, which is dead soft. It contains a high total carbon, 4 per cent., the maximum amount of graphite carbon, the minimum amount of combined carbon, a high silicon 3 per cent., and a low sulphur 0.03 per cent. Another cube is poured with a No. 4 grade of iron, which contains a lower total carbon, 3.5 per cent. Part of this is combined: a medium silicon content 2 per cent. and a rather higher sulphur 0.06 per cent. this metal is of medium hardness. The third cube is poured with a white iron, very hard, brittle and unmachinable. It contains a low total carbon, 2.5 per cent., with a maximum of combined carbon and a minimum of graphitic carbon and a high sulphur content over 0.10 per cent.

With the first cube, a No. 1 grade, the liquid shrinkage level is rather lower than the liquid line on the second cube, which is a No. 4 grade. Also underneath the shrinkage of the first cube some spongy places exist which is common with that grade of iron, this sponginess is unobservable in the second cube. The shrinkage line in the third cube, *i.e.*, white iron, is lower than either of the other two, and there is an entire absence of any sponginess, porosity or graphitic carbon in its appearance. So the conclusion arrived at is—a No. 1 grade to a No. 4 grade the liquid contraction is less, and from a No. 4 grade to a white iron the liquid contraction increases, and from a No. 1 grade to a white iron it becomes more dense and hard. The final conclusion is that a No. 4 grade exhibits the least liquid contraction, and, therefore, requires the least feeding.

Q.—What occurs as the freezing of cast iron takes place?

A.—An ordinary foundry iron was poured into a 12-inch cube at a medium temperature, say, about 1,400 deg. C. With a casting like this example solidification is fairly easy to follow. The casting is about 4 cwts., enclosed within six walls of sand. As heat is evolved, freezing generally commences at the bottom and sides and proceeds towards the top. As soon as molten iron rests on or against a wall of sand, transmission of heat is increased, and continues until solidification is complete. If the walls of sand are closer together than a 12-inch cube, freezing will be more rapid. If the walls of sand are further apart the freezing will be slower.

The top wall of sand which covers the casting will be the last to transmit heat, which is due to the gradual sinking away of the metal from it as liquid contraction is taking place, consequently the whole top surface of the cube is not in close contact with the sand which forms the top part, and transmission of heat is somewhat retarded. Eventually, when the solidification is complete, it will be found that although the mould formed a 12-inch cube the casting falls far short of this. It will be found that the casting at the top has a deep depression, and probably if cut through 3 inches reveals a cavity, possibly a gas cavity.

XUM

Sterling

SOLID RIBBED ROLLED STEEL

MOULDING BOXES

are recognised as standard box equipment by the leading foundries and engineering establishments in this country and overseas.

Because they speed up production, save unnecessary labour, produce accurate castings and make for all-round efficiency in the foundry.

STERLING BOXES WILL SAVE THEIR COST IN A FEW MONTHS.

WRITE FOR CATALOGUE No. 37.

Sterling

FOUNDRY BARROWS

for

SAND, COKE, and PIG-IRON

are sturdily built to withstand the heavy duties and harsh treatment of the severest foundry service.

STERLING FOUNDRY SPECIALTIES LTD.

London Office:
13, VICTORIA STREET, S.W.1.

BEDFORD.

Telephone: 3345 BEDFORD.
Telegrams: "STERFLASK, BEDFORD."
Code: WESTERN UNION.

WEEKLY PRICE CURRENT.

COPPER.

	£	s.	d.
Standard cash	70	6	3
Three months	70	6	3
Electrolytic	83	10	0
Tough	75	0	0
Best selected	75	10	0
Sheets	110	0	0
India	93	0	0
Wire bars	84	0	0
Do. Nov.	84	0	0
Do. Dec.	84	0	0
Ingot bars	—		
H.C. wire rods	86	5	0
Off. av. cash, September	75	6	9 1/16
Do., 3 mths., September	75	19	4 1/2
Do., Sttlmnt., September	75	7	1 5/7
Do., Electro, September	84	12	9 1/2
Do., B.S., September	79	18	1 1/2
Do., wire bars, September	84	18	4
Aver.spot price,copper,Sept.	75	6	9 1/16
Solid drawn tubes			15d.
Brazed tubes			15d.
Wire			11 1/2d.

BRASS.

Solid drawn tubes	12 3/4d.
Brazed tubes	14 1/4d.
Rods, drawn	12 1/4d.
Rods, extd. or rlld.	8d.
Sheets to 10 w.g.	11 3/4d.
Wire	11 1/4d.
Rolled metal	10 3/4d.
Yellow metal rods	8d.
Do. 4 × 4 Squares	8 1/4d.
Do. 4 × 3 Sheets	9d.

TIN.

	£	s.	d.
Standard cash	184	5	0
Three months	187	10	0
English	185	0	0
Bars	186	5	0
Straits	188	5	0
Australian	186	15	0
Eastern	189	2	6
Banca	196	5	0
Off. av. cash, September	204	18	9
Do., 3 mths, September	208	17	8 9/16
Do., Sttlmt., September	204	18	5 5/7
Aver. spot, September	204	18	9

SPELTER.

	£	s.	d.
Ordinary	22	1	3
Remelted	20	10	0
Hard	19	5	0
Electro 99.9	24	0	0
English	22	7	6
India	20	5	0
Zinc dust (Nom.)	33	10	0
Zinc ashes	7	5	0
Off. aver., September	24	8	11 1/2
Aver., spot, September	24	4	2

LEAD.

	£	s.	d.
Soft foreign ppt.	22	7	6
English	24	0	0
Off. average, September	23	11	5 1/2
Average spot, September	23	11	1 5/7

ZINC SHEETS, &c.

	£	s.	d.
Zinc sheets, English	31	10	0
Do. V.M. ex-whf.	30	0	0
Rods	35	0	0
Boiler plates	28	0	0
Battery plates	28	10	0

ANTIMONY.

	£	s.	d.
Special brands, Eng.	50	0	0
Chinese	31	0	0
Crude	20	15	0

QUICKSILVER.

	£	s.	d.
Quicksilver	22	7	6

FERRO-ALLOYS AND STEEL-MAKING METALS.

Ferro-silicon—	
25%	£7 17 6
45/50%	£11 15 0
75%	£19 0 0
Ferro-vanadium—	
35/50%	12/10 lb. Va.
Ferro-molybdenum—	
70/75% c. free	4/2 lb. Mo.
Ferro-titanium—	
23/25% carbonless	1/2 lb.
Ferro-phosphorus, 20/25%	£16 0 0
Ferro-tungsten—	
80/85%, c. fr.	3/3½ lb.
Tungsten metal powder—	
98/99%	3/6½ lb.
Ferro-chrome—	
2/4% car.	£31 0 0
4/6% car.	£23 5 0
6/8% car.	£21 17 6
8/10% car.	£21 10 0
Ferro-chrome—	
Max. 2% car.	£33 2 6
Max. 1% car.	£38 0 0
Max. 0.70% car.	£39 15 0
70%, carbonless	1/– lb.
Nickel—99% cubes, or pellets	£175 0 0
Ferro-cobalt	9/4 lb.
Aluminium 98/99%	£95 0 0
Metallic chromium—	
96/98%	2/6 lb.
Ferro-manganese (net)—	
76/80% loose	£13 10 0
76/80% packed	£14 10 0
76/80%, export	£14 0 0
Metallic manganese—	
94/96%, carbonless	1/6 lb.

Per ton unless otherwise stated.

HIGH-SPEED TOOL STEEL.

Finished bars, 14% tungsten	£0 2 0
Finished bars, 18% tungsten	£0 2 9

Per lb. net, d/d buyers' works.

Extras—

Rounds and squares, 3 in. and over	4d. lb.
Rounds and squares, under ½ in. to ¼ in.	3d. lb.
Do., under ¼ in. to 3/16 in.	1/– lb.
Flats, ½ in. × ¼ in. to under 1 in. × ¾ in.	3d. lb.
Do., under ¼ in. × ¼ in.	1/– lb.
Bevels of approved sizes and sections	6d. lb.

Bars cut to length, 10% extra.

SCRAP.

	£	s.	d.	£	s.	d.
South Wales—						
Heavy steel	3	13	6	to 3	15	0
Bundled steel and shrngs.	3	11	0	to 3	14	6
Mixed iron and steel	3	7	6	to 3	10	0
Heavy cast iron	2	17	6	to 2	18	6
Good machinery for foundries	3	0	0	to 3	5	0
Cleveland—						
Heavy steel				3	5	0
Steel turnings				2	17	6
Cast-iron borings				2	13	6
Heavy forge				3	15	0
W.I. piling scrap				3	10	0
Cast-iron scrap	3	6	0	to 3	8	6
Lancashire—						
Cast-iron scrap	3	2	6	to 3	10	0
Heavy wrought				4	0	0
Steel turnings				2	17	6
Scotland—						
Heavy steel				3	12	6
Cast-iron borings				2	15	0
Wrought-iron piling				3	19	6
Heavy machinery				3	10	0

London—Merchants' buying prices delivered yard.

	£	s.	d.
Copper (clean)	65	0	0
Brass	44	0	0
Lead (less usual draft)	21	0	0
Tea lead	18	0	0
Zinc	15	10	0
New aluminium cuttings	64	0	0
Braziery copper	58	0	0
Gunmetal	58	0	0
Hollow pewter	140	0	0
Shaped black pewter	100	0	0

PIG-IRON.

(f.o.t. unless otherwise stated.)

N.E. Coast—	
Foundry No. 1	75/–
Foundry No. 3	72/6
Foundry No. 4	71/6
Forge No. 4	71/–
Hematite No. 1	78/6
Hematite M/Nos.	78/–
N.W. Coast—	
Hem. M/Nos. d/d Glas.	86/–
,, d/d Birm.	93/6
Midlands—	
Staffs. common*	—
,, No. 4 forge*	75/6
,, No. 3 fdry.*	79/6
Shrops. basic	—
,, Cold blast, ord.	—
,, ,, roll iron	—
Northants forge*	71/–
,, fdry. No. 3*	75/–
Derbyshire forge*	74/6
,, fdry. No. 3*	78/6
,, basic*	—
Scotland—	
Foundry No. 1	78/6
,, No. 3	76/–
Hem. M/Nos.	80/–
Sheffield (d/d district)—	
Derby forge	69/9
,, fdry. No. 3	73/6
Lincs. forge	73/–
,, fdry. No. 3	77/–
E.C. hematite	88/6
W.C. hematite	89/6
Lincs. (at furnaces)—	
Forge No. 4	—
Foundry No. 3	—
Basic	—
Lancashire (d/d eq. Man.)—	
Derby forge	—
,, fdry. No. 3	77/–
Northants foundry No. 3	—
Dalzell, No. 3 (special)	105/– to 107/6
Summerlee, No. 3	93/–
Glengarnock, No. 3	—
Gartsherrie, No. 3	93/–
Monkland, No. 3	93/–
Shotts, No. 3	93/–

*d/d Black Country dist.

FINISHED IRON AND STEEL.

Usual District deliveries for iron; delivered consumers' station for steel.

Iron—	£	s.	d.	£	s.	d.
Bars (cr.) nom.				10	15	0
Nut and bolt iron	9	0	0	to 9	5	0
Hoops				11	0	0
Marked bars (Staffs) f.o.t.				12	10	0
Gas strip				11	0	0
Bolts and nuts, ¾ in. × 4 in.				15	5	0
Steel—						
Ship plates	8	12	6	to 8	17	6
Boiler plts.	9	12	6	to 10	10	0
Chequer plts.				10	12	6
Angles				8	2	6
Tees				9	2	6
Joists				8	2	6
Rounds and squares, 3 in. to 5½ in.				9	2	6
Rounds under 3 in. to ¾ in. (Untested)				8	2	6
				and upwards		
Flats—8 in. wide and over				8	7	6
,, under 8 in. and over 5 in.				8	12	6
Rails, heavy				8	10	0
Fishplates				12	10	0
Hoops (Staffs)				9	15	0
Black sheets, 24 g.				10	7	6
Galv.cor.shts., 24g.	13	0	0	to 13	7	6
Galv. fencing wire 8g. plain				12	0	0
Billets, soft	6	5	0	to 6	15	0
Billets, hard	7	10	0	to 8	0	0
Sheet bars				6	5	0
Tin bars				6	5	0

PHOSPHOR BRONZE.

	Per lb. basis.
Strip	1/4
Sheet to 10 w.g.	1/5
Wire	1/6¼
Rods	1/5
Tubes	1/9¼
Castings	1/4

Delivery 3 cwt. free.
10% phos. cop. £40 above B.S.
15% phos. cop. £50 above B.S.
Phosphor tin (5%) £30 above price of English ingots.
C. Clifford & Son, Limited.

NICKEL SILVER, &c.

	per lb.
Ingots for raising	10d. to 1/4
Rolled—	
To 9 in. wide	1/4 to 1/10
To 12 in. wide	1/4½ to 1/10½
To 15 in. wide	1/4½ to 1/10½
To 18 in. wide	1/5 to 1/11
To 21 in. wide	1/5½ to 1/11½
To 25 in. wide	1/6 to 2/–
Ingots for spoons and forks	10d. to 1/6½
Ingots rolled to spoon size	1/1 to 1/9½
Wire round—	
3/0 to 10 G.	1/7½ to 2/2½

with extras according to gauge.

AMERICAN IRON AND STEEL.

At Pittsburgh unless otherwise stated.

	Dols.
No. 2X foundry, Phila.	21.26
No. 2 foundry, Valley	18.50
No. 2 foundry, Birm.	14.50
Basic	20.26
Bessemer	20.76
Malleable	20.76
Grey forge	19.76
Ferro-mang. 80% d/d	105.00
O.-h. rails, h'y at mill	43.00
Bessemer billets	35.00
O.-h. billets	35.00
O.-h. sheet bars	35.00
Wire rods	40.00
	Cents.
Iron bars, Phila.	2.12
Steel bars	1.90
Tank plates	1.95
Beams, etc.	1.90
Skelp, grooved steel	1.90
Skelp, sheared steel	1.90
Steel hoops	2.20
Sheets, black, No. 24	2.75
Sheets, galv., No. 24	3.50
Sheets, blue an'l'd, No. 13	2.35
Wire nails	2.45
Plain wire	2.40
Barbed wire, galv.	3.10
Tinplates, 100-lb. box	$5.35

COKE (at ovens).

Welsh foundry	27/6
,, furnace	22/6 to 24/–
Durham and Northumberland—	
,, foundry	22/6
,, furnace	21/3
Midlands, foundry	—
,, furnace	21/6 and up

TINPLATES.

f.o.b. Bristol Channel ports.

I.C. cokes	20×14 box	18/9
,,	28×20 ,,	37/6
,,	20×10 ,,	27/6
,,	18¾×14 ,,	19/6
C.W.	20×14 ,,	15/6
,,	28×20 ,,	34/–
,,	20×10 ,,	22/7½
,,	18¾×14 ,,	16/–
Terneplates	28×20	33/6 per box basis f.o.b.

SWEDISH CHARCOAL IRON & STEEL.

Pig-iron	£6 0 0 to £7 10 0
Bars, hammered, basis	£17 10 0 to £18 10 0
Bars and nail-rods, rolled, basis	£15 15 0 to £16 15 0
Blooms	£10 0 0 to £12 0 0
Keg steel	£32 0 0 to £33 0 0
Faggot steel	£20 0 0 to £24 0 0
Bars and rods dead soft, steel	£11 0 0 to £14 0 0

All per English ton, f.o.b. Gothenburg.

TUBES AND FITTINGS.

Over ⅛ in. up to 6 in.

	Tubes.	*Fittings.*
Gas	65%	47½%
Water	61½%	42½%
Steam	57½%	37½%

W.I. 10% extra.

DAILY FLUCTUATIONS.

Standard Copper (cash).

			£	s.	d.	
Oct.	24	..	72	7	6	dec. 13/9
,,	25	..	72	1	3	,, 6/3
,,	28	..	72	2	6	inc. 1/3
,,	29	..	71	5	0	dec. 17/6
,,	30	..	70	6	3	,, 18/9

Electrolytic Copper.

			£	s.	d.		
Oct.	24	..	83	15	0	No change	
,,	25	..	83	15	0	,,	,,
,,	28	..	83	10	0	dec.	5/–
,,	29	..	83	10	0	No change	
,,	30	..	83	10	0	,,	,,

Standard Tin (cash).

			£	s.	d.		
Oct.	24	..	188	15	0	dec.	15/–
,,	25	..	186	15	0	,,	40/–
,,	28	..	183	10	0	,,	65/–
,,	29	..	184	5	0	inc.	15/–
,,	30	..	184	5	0	No change	

Tin (English ingots).

			£	s.	d.		
Oct.	24	..	189	0	0	dec.	30/–
,,	25	..	187	0	0	,,	40/–
,,	28	..	183	15	0	,,	65/–
,,	29	..	184	5	0	inc.	10/–
,,	30	..	185	0	0	,,	15/–

Zinc Sheets (English).

			£	s.	d.		
Oct.	24	..	31	10	0	No change	
,,	25	..	31	10	0	,,	,,
,,	28	..	31	10	0	,,	,,
,,	29	..	31	10	0	,,	,,
,,	30	..	31	10	0	,,	,,

Spelter (ordinary).

			£	s.	d.		
Oct.	24	..	22	10	0	inc.	2/6
,,	25	..	22	12	6	,,	2/6
,,	28	..	22	2	6	dec.	10/–
,,	29	..	22	0	0	,,	2/6
,,	30	..	22	1	3	inc.	1/3

Lead (English).

			£	s.	d.		
Oct.	24	..	25	0	0	inc.	5 –
,,	25	..	25	0	0	No change	
,,	28	..	25	0	0	,,	,,
,,	29	..	24	10	0	dec.	10/-
,,	30	..	24	0	0	,,	10/–

AVERAGE MONTHLY PRICES OF MARKED BARS (SOUTH STAFFS).

Year.	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Yearly average.
	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
1897	7 10 0	7 10 0	7 10 0	7 10 0	7 10 0	7 10 0	7 10 0	7 10 0	7 10 0	7 10 0	7 10 0	7 10 0	7 10 0
1898	7 10 0	7 10 0	7 10 0	7 10 0	7 10 0	7 10 0	7 10 0	7 10 0	7 10 0	7 10 0	8 0 0	8 0 0	7 11 8
1899	8 0 0	8 0 0	8 0 0	8 0 0	8 10 0	8 10 0	9 0 0	9 10 0	10 0 0	10 0 0	10 0 0	10 0 0	8 3 4
1900	11 0 0	11 10 0	11 10 0	11 10 0	11 10 0	11 10 0	11 10 0	11 10 0	11 10 0	11 10 0	11 10 0	11 10 0	11 5 10
1901	9 10 0	9 10 0	9 10 0	9 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 16 8
1902	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 5 0	8 5 0	8 5 0	8 5 0	8 5 0	8 5 0	8 7 6
1903	8 5 0	8 5 0	8 5 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 8 9
1904	8 10 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 10
1905	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 10 0	8 10 0	8 1 8
1906	8 10 0	9 0 0	9 0 0	9 0 0	9 0 0	9 0 0	9 0 0	8 10 0	8 10 0	8 10 0	8 10 0	9 0 0	8 15 10
1907	9 0 0	9 0 0	9 0 0	9 0 0	9 0 0	9 0 0	9 0 0	9 0 0	9 0 0	9 0 0	9 0 0	9 0 0	9 0 0
1908	9 0 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 5 10
1909	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0
1910	8 0 0	8 0 0	8 0 0	8 0 9	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0
1911	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0
1912	8 10 0	8 10 0	8 10 0	8 15 0	9 0 0	9 0 0	9 0 0	9 8 0	9 10 0	9 10 0	9 10 0	9 15 0	9 1 6
1913	10 0 0	10 0 0	10 0 0	10 0 0	10 0 0	10 0 0	10 0 0	9 10 0	9 10 0	9 4 0	9 0 0	9 0 0	9 13 8
1914	8 12 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	9 0 0	9 0 0	9 0 0	9 0 0	9 0 0	8 14 4
1915	9 0 0	9 0 0	9 3 0	10 2 0	10 15 0	11 10 0	12 0 0	12 0 0	12 0 0	12 7 6	12 10 0	13 10 0	11 5 0
1916	13 10 0	13 10 0	14 13 0	15 0 0	15 0 0	15 0 0	15 0 0	15 10 0	15 10 0	15 0 0	15 10 0	15 0 0	14 18 7
1917	15 10 0	15 10 0	15 10 0	15 10 0	15 10 0	15 10 0	15 10 0	15 10 0	15 10 0	15 10 0	15 10 0	15 10 0	15 10 0
1918	15 12 6	16 0 0	16 0 0	16 0 0	16 0 0	16 0 0	16 0 0	16 0 0	16 0 0	17 0 0	17 0 0	17 0 0	16 6 3
1919	18 0 0	18 10 0	20 0 0	20 0 0	23 0 0	23 0 0	23 0 0	24 12 0	25 0 0	25 0 0	25 0 0	25 5 0	22 10 7
1920	26 17 6	27 0 0	28 0 0	30 5 0	30 10 0	33 10 0	33 10 0	33 10 0	33 10 0	33 10 0	33 10 0	33 10 0	31 10 2
1921	31 10 0	30 3 4	27 10 0	27 10 0	24 15 0	21 0 0	20 0 0	20 0 0	20 0 0	17 10 0	17 0 0	16 0 0	23 7 4
1922	16 0 0	14 17 6	14 10 0	13 10 0	13 10 0	13 10 0	13 10 0	13 10 0	13 10 0	13 10 0	13 10 0	13 10 0	13 18 1½
1923	13 10 0	13 10 0	13 16 0	14 7 6	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0	14 5 3½
1924	14 10 0	14 10 0	14 10 0	15 0 0	15 0 0	15 0 0	15 0 0	15 0 0	15 0 0	15 0 0	15 0 0	14 17 6	14 17 3½
1925	15 0 0	15 0 0	15 0 0	15 0 0	15 0 0	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0	14 0 0	14 13 4
1926	14 0 0	14 0 0	14 0 0	14 0 0	14 0 0	14 0 0	14 0 0	14 0 0	14 0 0	14 0 0	—*	14 10 0	14 0 10
1927	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0	13 10 0	13 10 0	13 10 0	13 10 0	13 0 0	13 0 0	12 18 0	13 15 8
1928	12 10 0	12 10 0	12 10 0	12 2 6	12 0 0	12 0 0	12 0 0	12 0 0	12 0 0	12 0 0	12 0 0	12 0 0	12 2 8½
1929	12 0 0	12 0 0	12 0 0	12 0 0	12 0 0	12 0 0	12 0 0	12 0 0	12 0 0	12 7 6	—	—	—

* No quotation available.

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